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POWER

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The Happily Discontented

I KNOW men who owe their success in life to a swift kick.

If they had not been jolted out of them, they would still be contentedly filling little jobs instead of responsible positions, not even getting along, but laying to and letting the years glide by.

And then something happens that makes them fight for a living.

Some of them simply scramble into other ruts, some flounder, call for help and get the habit of looking for lifts, but some are aroused to real endeavor, find that they have abilities and resources and use them as they never have before.

A good loser is an eventual winner.

And it takes a spell of losing sometimes to excite and activate the winning qualities in a man.

Quiet contentment with things as they are does not conduce to progress.

And when it is indulged to a state of listlessness, it is likely to lead to a condition where content is no longer possible.

A certain amount of good-natured discontent, of desire for betterment, is good for a fellow if it leads to an intelligent effort to bring it about.

I don't mean the grouch who no sooner gets onto a job than he begins to growl at the pay and the conditions and outlook. He is a pest who is more likely to be shown the way out than to be yielded the way up.

But the man who has a laudable ambition for a higher scale of living, the intelligence to know that he must give a *quid pro quo* for it; who has the ability to do something worth while, to do it more than ordinarily well, and the gumption to find somebody who wants it done and expects to pay what it is worth.

His is the contentment that comes with achievement and the enjoyment of its returns.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Cheaper Power Through Modern Equipment

PLANT modernizing that saves money does not always mean the purchase of new generating equipment. Sometimes a splendid showing can be made by bringing the transmission or application equipment up to date. In fact, many plants will be found where the evil of high cost results entirely from conditions outside the power-house walls. The boilers, turbines or engines may be modern and efficient, and the waste may be confined to the motors, compressed air lines or some similar part of the plant.

For instance, cheaply made steam may be so poorly distributed in the heating system that the cost per square foot of radiation is excessive. That was the case until recently at Vassar College. When the steam distribution system there had been thoroughly modernized, it was found that great savings had been effected. Over two thousand tons of coal yearly was saved, while at the same time an increase in load of ten per cent was accommodated. Also, it was found that no additional boilers were necessary. Quite the contrary—one boiler was shut down, leaving excess capacity for future additions.

Here is an example of what can be accomplished through the use of modern equipment for transmission and application. The engineer who follows such a course will come to look at his entire plant equipment as an opportunity to obtain cheaper power through modernization.

Water Power and Coal

THE coal industry has been in bad shape for several years. Some measure of blame for these conditions has been assigned to those central-station engineers who have so reduced the coal consumption per kilowatt-hour of output that there has been relatively little increase in the tonnage of coal used by central stations, although the total electrical output has steadily increased.

While this reduction in expected coal consumption undoubtedly has had a serious effect on the industry, the increase in water power development has also been a significant factor. This will become more apparent when one considers that hydro-electric plants are now generally tied electrically into large power distribution systems. These systems can absorb the total capacity that can be generated from the river flow. Each kilowatt-hour thus supplied may be said to replace coal that would otherwise be burned under boilers. For instance, if the present capacity of the new Conowingo plant on the Susquehanna River, totaling 280,000 kw., could be operated at 70 per cent capacity factor throughout the year, the equivalent power output, if generated by steam stations, would require the production of about one and a quarter million tons of coal per year. This includes coal used at the mines, on the railroads for transportation and in the steam central stations. It would require several mines to furnish this output of coal. Put in another way, the Conowingo development may be considered equivalent to closing down these mines with the consequent losses to owners, to miners and to transporting railroads.

The extended development and utilization of our water powers in order to reduce the cost of bulk electric power, is very commendable. Few people recognize the economic effect of such developments in prolonging the stagnation in our coal industry.

Elimination of Surface Condenser Leakage

BOILERS that operate at high ratings must be supplied with pure feed water. Impurities precipitated as solids are deposited on heating surfaces and may cause them to be burned out. The salts that remain soluble at the steam temperatures in the boiler increase concentration, necessitate frequent blowdown, and thereby cause excessive heat loss.

In view of this, condensate from surface condensers should be free from impurities such as may enter through leaks at the tube ends. When salt or impure harbor water must be used as circulating water, it is particularly essential that leakage be kept to a minimum.

Various forms of stuffing boxes with tube packings ranging from corset lacing and fiber, to metallic packings, have been tried. None has proved absolutely leak-proof owing to human and mechanical variables. The next step was to roll the tubes into the tube sheet where the water enters the tube and pack only the discharge ends. This appears to have been a decided improvement. A later proposal was to roll the tubes at both ends, but to have one tube sheet serve as a floating head sealed by a flexible diaphragm or gasket. The latest advance in this direction is to be found in one of the new central stations, where the tubes are rolled at both ends to tube sheets firmly fixed to the shell. The tubes are bowed up one and one-half inches in their length of eighteen feet and

are held in this position by two intermediate support plates. The plant has operated fifteen months and an excellent record of freedom from leakage has been reported.

This method of constructing condensers has much to commend it. It must cost less to roll tubes into sheets than to drill and tap for ferrules and to pack the tubes in place. The tubes themselves take the place of staybolts and permit a better use of tube-sheet surface. Finally, if present indications are a fair index of performance, this construction promises a large measure of freedom from leakage and better boiler feed water.

Bleeding the Steam Engine

MANY an engineer who knows the advantages of extracting steam for use in process equipment associates the possibilities solely with the steam turbine. Perhaps this is natural, since steam extraction has been played up as one of the distinct advantages of the turbine.

On the other hand, the reciprocating engine has large possibilities in this direction. For the compound, or multiple-expansion, engine, this is well known. Many years ago Nordberg built splendid hoisting engines with extraction from the receivers. It is perhaps not so widely realized that the same thing can be done with the single-cylinder engine through the use of a special valve gear that catches steam at the desired pressure during the compression stroke and lets it out to the extraction piping. This is being developed at the present time.

An interesting possibility is the use of two independent engines in series. The economy on the steam side is that of the compound engine, but by adjusting the division of load between the two engines, it is possible to vary the pressure in the intermediate receiver within the physical limits of the set-up, or to meet any reasonable variations in the demand for steam.

The turbine has its merits, but so has the piston engine. To a certain extent, either can be combined with steam extraction.

Solving the Power-Factor Problem at the Generators

THE first place to improve power factor is at the load. This reduces the losses in lines and equipment all the way back to the generating station, improves voltage regulation and allows supplying the load with less connected generator and transformer capacity. If conditions are such that the power factor cannot be corrected at the load, then there is the possibility of doing it in the power house, by operating one or more of the generators as synchronous condensers.

In the hydro-electric field, operation of certain generators in a station as synchronous condensers has become an accepted practice. Where a plant experiences periods of low water, the idle units may well be used to supply wattless current to the system and improve the voltage regulation. It will generally be found necessary to make some changes in the machines to operate them as synchronous condensers, but the cost of doing this is small, as experience with several plants has shown. When new plants are being designed, this feature of operation should be provided for.

Steam plants have not accepted this method as generally as have water-power plants. A steam turbine cannot be operated without passing enough steam to keep its temperature within safe limits. Operation of the complete unit as a synchronous condenser improves the station's efficiency little, if any, over operating all machines as generators. The answer is, disconnect the turbine, and some of the new designs provide for this.

The power-factor problem, like the weather, is always with us. No one single plan of attack is going to solve it. In some cases it can be taken care of at the load, in others on the lines, and in still others the power house is the place.

Increased Power Versus Unemployment

IN HIS Labor Day address, President Green of the American Federation of Labor stressed the increasing use of power in industry. Conceding that new industries and greater social needs have thus far largely absorbed workers displaced by machinery, he, nevertheless, expresses some fear lest the point of saturation be near. Sensing consequent unemployment, he urges as partial remedies extension of the five-day week and co-operation of the Government through appropriations for public projects to be executed during such periods.

The latter suggestion, while not new, is excellent as a temporary measure during periods of depression. It could not be regarded as a permanent remedy unless the Government were to embark upon a program so extensive as to be undesirable from many angles. The five-day week, of course, presents a permanent measure and in certain lines would undoubtedly absorb more labor; in other lines its effect might be negligible.

Increased use of power, accompanied by greater production and high wages, higher standards of living and more time for the enjoyment of luxuries all tend toward a gradual adjustment in the hours of labor. Just as the twelve-hour day gave way to the ten, and the ten to the eight, so, it would appear, we are headed ultimately toward the five-day week. Arbitrary reduction as an expedient in the interest of labor, however, might easily upset the economic balance and precipitate trouble.

It is rather surprising to hear a man of Mr. Green's broad vision express concern over the increasing use of industrial power. Instead, one would expect him to voice confidence in the ability of American business to absorb labor through the creation of new industries and new markets, as it has so ably done in the past.

DISTRIBUTING STEAM

Efficiently Saves Coal

By Keene Richards
Consulting Engineer, Poughkeepsie, N.Y.

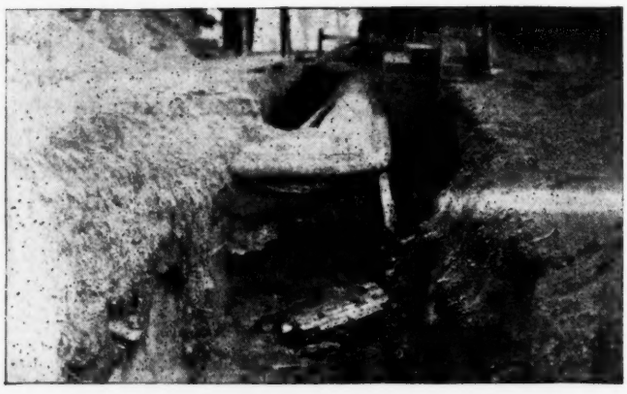


Fig. 1—Condition of old brick heating ducts. These ducts were frequently flooded

VASSAR COLLEGE is in Poughkeepsie, New York. It occupies a total area of some 904 acres, 208 of which comprise the campus. On this property are 57 buildings, with a floor area of 1,190,656 sq.ft., heated from the steam distribution system. The buildings are of various ages and types of construction, ranging from the original main building of brick construction, with brick interior partitions and wood floors, to the best type of modern fire-resisting construction. A number of different types of heating are used in the various buildings, direct radiation predominating, but including gravity indirect heating, indirect heating with fan circulation, and unit heating.

In 1925 the increasing load on the boiler plant, the deteriorated condition of the underground heating mains and the fact that several additional buildings were to be erected on the campus, made it necessary that steps be taken to rehabilitate the steam distribution system. The writer made a complete investigation of the entire plant that spring. The rehabilitation program carried out over a period of two and a half years was the result.

Steam was supplied to the system both from the exhaust of reciprocating engines in the power plant at a back pressure of 4½ lb., and through a reducing valve from the boilers at a pressure of 16 lb. In addition, a high-pressure system delivered steam to various parts of the campus at approximately 75 lb. for use in the kitchens. A certain portion of the condensation was returned to the boiler house by direct-acting vacuum pumps, all of which were badly worn.

All the lines were in bad condition, and in many cases the type of construction was either unsuited to conditions or obsolete. The older parts of the campus were served by mains installed in small brick conduits, the pipe being insulated with various forms of magnesia, asbestos and air cell covering. These ducts were not water-tight, and in the majority of cases the covering was either nonexistent or hanging in shreds from the piping. Expansion was generally taken care of by means of bends or swing fittings. Many of these ducts were close to the surface of the ground, and their path could be traced by burned sod in summer and melting snow in winter.

Some of the later buildings were served by steam mains carried in brick or concrete tunnels, generally about 6 ft. high by 4 ft. wide. The insulation on the pipe in these tunnels was found to be in better condition, but corrosion and leaks were abundant, resulting in low pressure, loss of condensation and low efficiency. They were built in sandy soil and had no bottom slabs. As a result, any rise in ground water filled them within a few inches of the pipe lines. In some cases these tunnels carried, in addition to the steam mains, electrical circuits, water lines, telephone cable and other services.

The proposed new college buildings required extensive additions to the steam mains and, unless more efficient

Fig. 2—Construction of tunnel, showing brackets for supporting main and a portion of the roof form in place

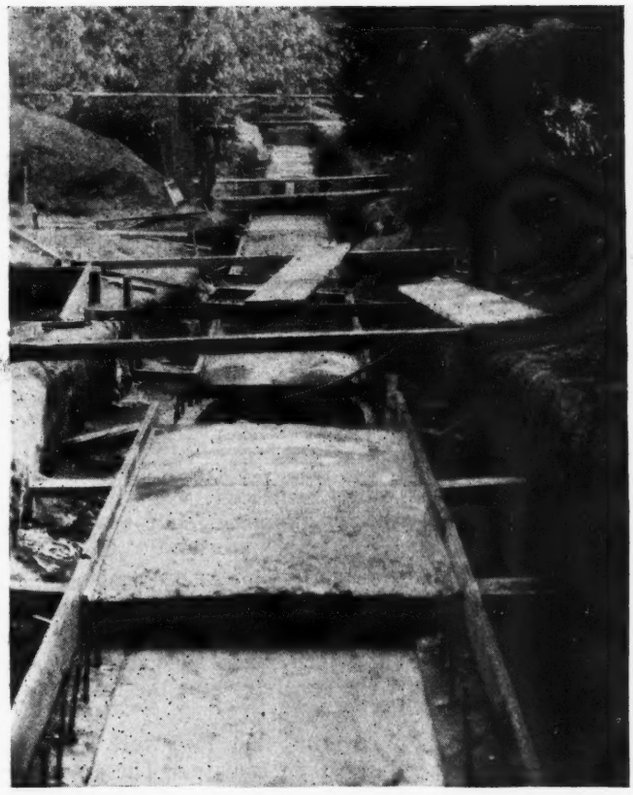


Fig. 3 Method of pouring roof slabs on the tunnel. Slabs were poured alternately to provide for expansion joints

distribution could be secured, would require a material increase in the size of the boiler plant.

Some 3,900 ft. from the boiler plant on a residential street was a pumping station, operated by the college. The exhaust steam, supplemented by live steam from the boilers at this location, furnished heat for a faculty apartment building, the Alumnæ House, and a group of faculty residences. The college discontinued pumping water at this time, so that it became necessary to operate these boilers entirely for the heating load. This entailed the services of two firemen and made necessary the use of anthracite at this location, while the main plant was burning a low-grade mine-run bituminous coal. It was decided, if possible, to serve the buildings in this location from the main plant.

A number of types of construction were studied, and the requirements seemed to fall into two classes: First, that portion of the campus where the buildings were close together and where services other than steam must be carried between buildings and must be accessible. This was practically limited to the science group, where it was necessary to carry high- and low-pressure steam, with their return lines, compressed air, and water. It was decided at this time to discontinue placing electric circuits in tunnels, as the standard duct distribution system using lead cable appeared to be more advantageous.

The second classification required a system of lower cost suitable for distribution over long distances, with a reasonable degree of accessibility and a high degree of reliability, as the failure of a steam main during winter weather would cause great inconvenience to, if not total suspension of, college activities. It was absolutely essential that all these methods provide adequate protection against water, as the campus subsoil is very wet.

Construction work was started in the summer of 1925, on a tunnel to replace existing lines to the Assembly Hall and the Sanders Chemical Laboratory, with an extension to supply the new Sanders Laboratory of Physics. This tunnel is built of reinforced concrete throughout, the bottom and sides being poured together with the reinforcing projecting into the top, which was poured in alternate slabs after the installation of piping. Expansion joints in the concrete were provided on 8-ft. centers. A Vee-type joint, using 4-ply felt, mopped on with pitch, was used. This proved to be entirely satisfactory.

The mains were carried on roller pipe chairs, mounted on a standard type of welded structural bracket, bolted to inserts, all of which were furnished by the Grinnell Company. Manholes were provided at intervals and were covered with the double-type manhole cover furnished by the American District Steam Company. The steam supply main was insulated with 2-in. thick 85 per cent magnesia pipe covering, and the return with standard thickness 85 per cent magnesia pipe covering. The usual drips were provided, the line being graded back toward the boiler plant.

This portion of the system is supplied by exhaust steam from the engines, but designed for 100-lb. working pressure to take care of any changes that might be made in the future. The steam supplying this group of buildings leaves the exhaust header in the power plant through a 10-in. main, which is reduced to 8 in. at the Assembly Hall and to 6 in. between the chemical laboratory and the laboratory of physics. The return line varies in size from 4 to 3 in. It carries the returns from the low-pressure and high-pressure lines. The cost of this tunnel construction, including all items for both the tunnel and the piping installation, was $36 per foot.

The operating costs of the small heating plant supplying the faculty apartment house and the Alumnæ House were such that a study of the situation proved conclusively that a line built to serve this group of buildings would lower the cost of steam enough to

Fig. 4—Forms in place for concrete duct, showing method of pouring alternate sections

return the investment within four years. A portion of this line would be necessary in any case in order to serve Kendrick House, a faculty apartment building on which construction was to be started in 1926.

Plans were therefore made to replace the lines supplying the Chapel, Taylor Hall and the Library, with an extension serving Kendrick House and the Alumnæ House—Williams Hall group. The construction of this line would make it possible to supply central heating to a group of faculty houses, the occupants of which very much desired this service. This line, when complete, would have a total length of 3,900 ft. from the boiler house to the farthest heating connection. A careful investigation indicated that it would be possible to return the condensation from this line.

The second class of construction was decided upon. The dimensions of the duct and the sizes of the piping were influenced both by the load and by the economic phases of the situation. It was found that a duct having an inside width of 26 in. and a depth of 24 in. was about the smallest size in which a man could stand and handle pipe during construction. The maximum size of piping that could be carried in the duct was a 10-in. supply main and a 4-in. return.

It was necessary to have a final pressure of 15 lb. in order to take care of cooking appliances in the kitchens. This was done easily by taking an initial pressure of 30 lb., giving a drop in pressure on this line of 8 to 10 lb. in actual service.

At this time it was necessary to go into the entire question of steam supply for kitchens. The old high-pressure lines were in bad condition, and it seemed perfectly feasible to dispense with them entirely, with the exception of the line to the science group. Investigation indicated that a pressure of 15 lb. was entirely adequate. It was therefore decided to carry from 25 to 30 lb. pressure on the heating system, installing reducing valves in each building for steam distribution to the radiation and connecting the kitchen and hot-water tank supply lines on the high-pressure side of the reducing valve. This worked out satisfactorily.

Construction was started on this new duct in the spring of 1926. Connection was made to an existing low-pressure line in the main tunnel from the boiler house to Main Building, and a main and return were carried through the basement of this building, leaving it at the west end of the south wing. Expansion joints were placed every 15 ft. in the concrete. These joints consisted of four plies of felt mopped on with pitch, providing a watertight joint which made adequate provision for the expansion of the concrete after the mains were turned on.

Fig. 5—Section of duct complete, with forms still in place, showing connection to concrete manhole

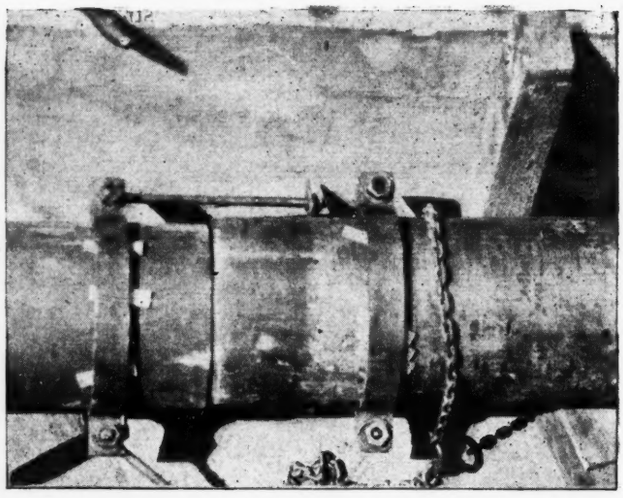


Fig. 6—Clamp used for lining up pipe for welding

The top slabs for covering this duct were cast separately in sections 2 ft. 10 in. square. These sections were about the maximum size that could be handled without special equipment. Manholes were cast of concrete, with an expansion joint at the duct connection. The standard type of double manhole cover furnished by the American District Steam Company was used at all manholes.

As soon as a section of duct from manhole to manhole was completed, pipe was lowered and placed on rollers ready for welding. All pipe used was full weight wrought iron, obtained with beveled edges. Pipe was lined up for welding by means of clamps and wedges. Welding was done with an acetylene torch, one man and a helper doing all the work. Flanged joints were used in manholes for connections to expansion joints and fittings. This work was all designed for 100 lb. working pressure to allow for future loads.

When a section between manholes had been welded, it was blanked off and given a test under 100 lb. steam pressure. This served not only as a test as to the condition of welds, but also as a check on the functioning of expansion devices. It is interesting to note that in the installation of some 10,000 ft. of pipe only three minor leaks developed on test. These were closed in a few moments with a welding torch, and after two years of service not a single leak has developed in any weld. This is due not only to the methods used, but to the high degree of craftsmanship practiced by the welder. After test the piping was painted with black asphaltum paint, and 85 per cent magnesia covering applied, double thickness being used on the mains and single on the returns.

All fittings in manholes were covered, and shutters of wood plank were fitted in the ends of the duct at each manhole. These shutters prevent circulation of air and thereby decrease the heat loss. After covering, the top slabs were placed on the duct. These slab joints were made with four plies of building paper and pitch, to make a watertight joint and to allow for expansion. This method of using separate top slabs makes it possible to remove a slab should leaks develop.

This duct crossed a main state highway at one point. As the Highway Department required replacement of an entire concrete slab when this crossing was made, it was decided to use a tunnel at this point and carry all other services to Kendrick House through this tunnel, in addition to the heating mains, so that future developments or leaks would not necessitate the opening of the pavements a second time. Heavy reinforcement was necessary to take care of the dead and live loads on the highway, and under-drainage was required to keep the tunnel dry. The steam main was carried on structural iron brackets, a manhole being located at each end of the tunnel where it connects with the duct system.

This entire line was graded toward the boiler house wherever possible, but contains several up-grades which could not be avoided without excessive excavation. Expansion was cared for by means of the slip type of expansion joint installed in manholes. A structural shape was embedded in the concrete when the manhole was built, and the base of the expansion joint was bolted to this channel iron. Expansion joints manufactured by the American District Steam Company were used. Where service connections were taken from the lines, they were made through a tap provided in the casting of the expansion joint.

This line was put in service in August, 1926, and has been continuously in operation since that time. Condensation has been returned without difficulty with a vacuum of from 10 to 11 in. at the boiler house.

In 1927 the addition of Cushing Hall, Blodgett Hall and the Nursery School made necessary an extension of the heating system to serve these buildings. The duct type of construction was used, with the exception of the line from Blodgett Hall to the Nursery School. As the load is light at this point and the building small, it was decided to use Wyckoff wood covering, which was installed in the usual manner over a welded wrought-iron line. The grade of the lower floor of the Nursery School is considerably below the best possible grade of a steam main. This entailed a lift of 7 ft. 9 in. No difficulty has been experienced with this lift. Lift fittings were installed in the manhole at this point.

Wyckoff or American District Steam Company wood duct has been used for all service connections to houses

Fig. 7—Covering in place. Setting top slabs and back-filling

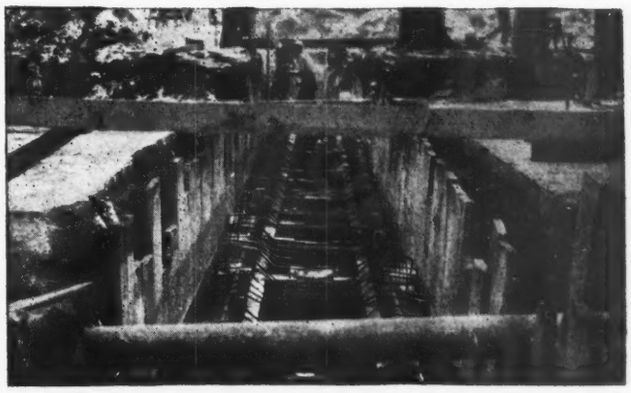


Fig. 8—Construction of tunnel under state highway

and has proved to be a very economical combination insulation and duct for that purpose. The same type of manhole has been used in connection with this duct as with the concrete duct, the wood covering being built into the concrete walls. The cost of this type of construction has averaged about $9.50 per foot.

Considering all the questions of first cost, reliability, accessibility and speed of construction, it is believed that the concrete duct is the most advantageous. While the cost of this duct has varied somewhat, owing to depth below the surface and soil conditions, the average cost of this construction has been $13.62 per foot. This has included excavation, duct construction, pipe construction and covering, back-filling and restoring sod. No work was done under pavement with the exception of a few minor driveway crossings.

Owing to inability to secure accurate data as to steam consumption previous to the rehabilitation of this heating system, the savings effected will necessarily be based on coal consumption. The total amount of equivalent radiation connected to the system is 146,461 sq.ft., which is an increase over 1925 of 14,780 sq.ft., or a total of more than 10 per cent. In 1925 difficulty was experienced in getting steam to certain buildings, none of which difficulty is experienced at the present time. The total coal consumption for the fiscal year ending June 30, 1925, was 14,700 tons. This was reduced to 11,660 tons for the year ending June 30, 1926. The coal consumption for the year ending June 30, 1927, after the 10 per cent load increase, was 12,650 tons.

Further savings were effected in the labor cost of firemen who had been employed in the isolated heating plant which was shut down. The cost of repairs and maintenance was greatly reduced. A policy of keeping steam mains hot 24 hours a day throughout the year has resulted in a material decrease in maintenance expense. The heat in the various buildings is regulated at the building. Previously, steam mains were shut off at night, which resulted in leaks and difficulties with expansion joints.

This rehabilitation not only has accomplished a marked saving in operating expense, but in connection with the rehabilitation of the boiler plant has made it possible to carry the additional 10 per cent load which was added in 1927 and has made it possible to carry the peak load on four boilers, whereas formerly five were required to carry the lighter load. Therefore, no addition was required to the boiler house, and should the college add to the number of buildings on the campus, the existing boiler plant would still be able to care for them.

Meter Readings and Signals

Transmitted by Selsyn Motors

By A. E. Bailey
Switchgear Department, General Electric Company

Although the applications in this article are in the power house, the system is applicable to a wide range of uses in industrial processes, for transmitting temperature, humidity, fluid levels and pressure indications.

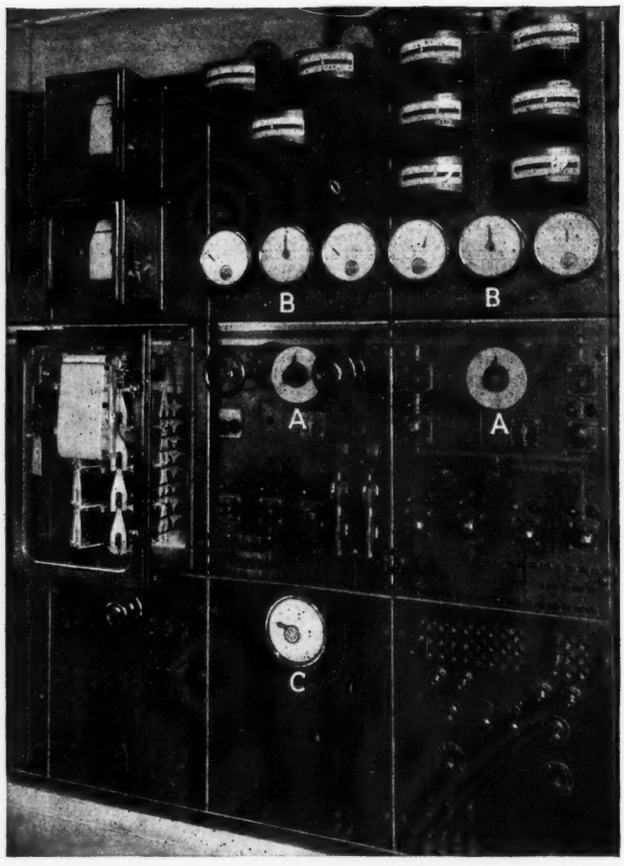


Fig. 2—Signal transmitters and receivers are located at A and B respectively

IN THE design of any modern power plant the problem of communication between the switchboard room and generator floor is of vital importance. In the past, when generators and switchboards were relatively small, it was common practice to place them on the same floor and close together, so that, if necessary, one man could operate both. Later, as the generators increased in size and number, it became necessary to place the switchboard on a gallery overlooking the generators. The switchboard operators and the generator attendants then resorted to a "wigwag" system, using the hands and arms to convey their orders.

Today, the size of the switchboard, the lack of ground space, the economy of building higher rather than longer and wider structures has in most cases resulted in placing the switchboard in a separate room several floors above the generators.

At Whippany station of the Jersey Central Power & Light Company the problem of rapid and reliable communication was solved by the use of alternating-current self-synchronous indicators. These indicators are used and sold under the trade mark "selsyn."

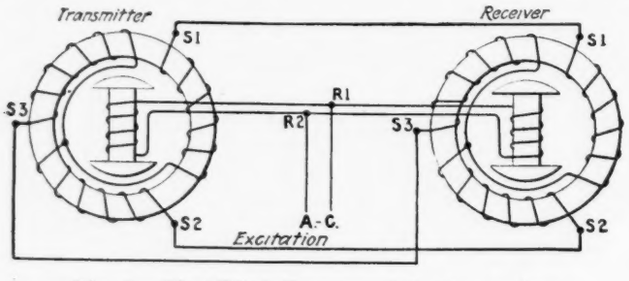


Fig. 1—Simplified diagram of the transmitter and receiver connections

Selsyn indicators are essentially small motors which, when interconnected, function so that if one motor of a combination is turned, the other reproduces the same angle at a distant point. Fig. 4 illustrates the type of indicator used in the Whippany installation. For any signaling system of this type at least two units are required—one to be used as a transmitter and the other as a receiver. Connection diagram for such a combination is shown in Fig. 1. The rotors are shuttle-wound with definite poles, and the winding is connected through slip rings to a single-phase source of alternating current. The same source should be used for exciting the transmitter as is used for the receiver. If there is more than one receiver, they are all connected in parallel.

With the supply circuit closed, as in Fig. 1, an alternating voltage is impressed upon the rotors, and as the receiver rotor is free to turn, it will take up a position in correspondence with the transmitter rotor, and if the transmitter is turned the receiver will follow at the same speed and in the same direction. The reason for this synchronous operation is that the single-phase current in the rotor induces voltages in the three legs of the stator circuits. These three voltages are unequal and vary with varying positions of the rotors. If the receiver rotor is in exact correspondence with the transmitter rotor, the voltages induced in the receivor stator equal and balance those induced in the transmitter stator, so that no current will flow in the stator or secondary circuits.

If the receiver rotor is restrained from assuming the

same position as that of the transmitter, the voltages induced in the transmitter and receiver stators will no longer be equal and balanced, and current will flow in the stator circuits. This current will react upon the rotors, setting up a torque which tends to bring them into agreement. As the transmitter rotor is held mechanically or manually in a definite position, the torque reacts against the force which restrains the receiver, tending to bring it into correspondence with the transmitter. A selsyn indicator always tends to seek that position where it is in synchronism with the transmitter, resisting any effort to coerce it from that position. Handles and pointers are attached to the transmitter shaft, while pointers are attached to the shaft of the receiver.

The operation of the signals is rapid, reliable and readily understood. No special instructions to the operators are necessary before using. The alternating-current self-synchronous indicators are constructed in the same manner as small fan motors, except that the stator is wound three-phase and the rotor single-phase. Brushes are of silver with a graphite core and the slip rings are of silver for the size used in this installation.

Fig. 2 is an illustration of a section of the switchboard showing the transmitters with their dials mounted on the middle section, at *A*, and immediately above them, on the upper section of the panel, are shown the repeat-back indicators at *B*. When the switchboard operator desires to signal to a generator, he first operates a small tumbler switch adjacent to the transmitter. This rings a bell in the generator room and lights a lamp at the particular

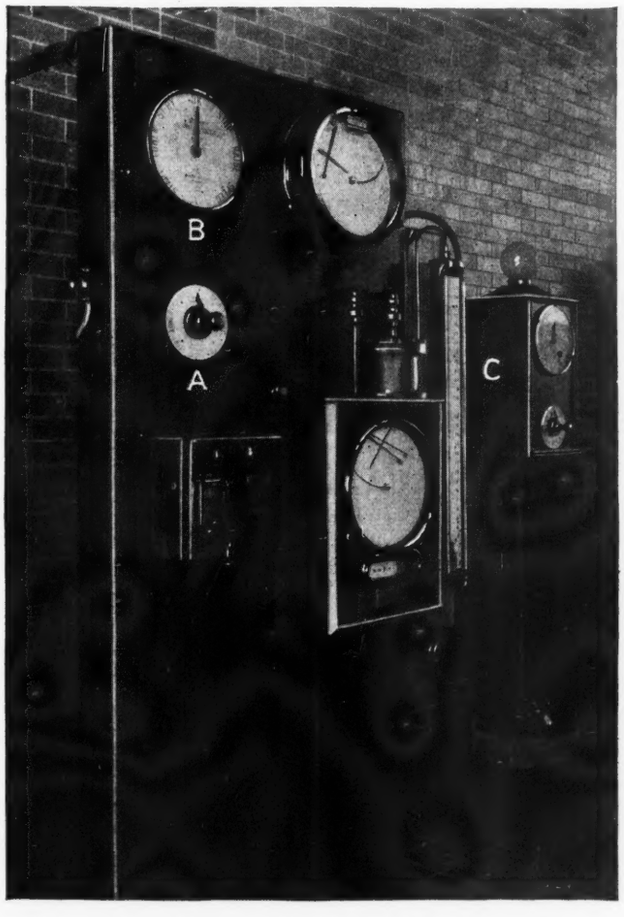


Fig. 3—Turbine gage board with signal transmitter and receiver at A and B respectively, and the service generator signal pedestal at C

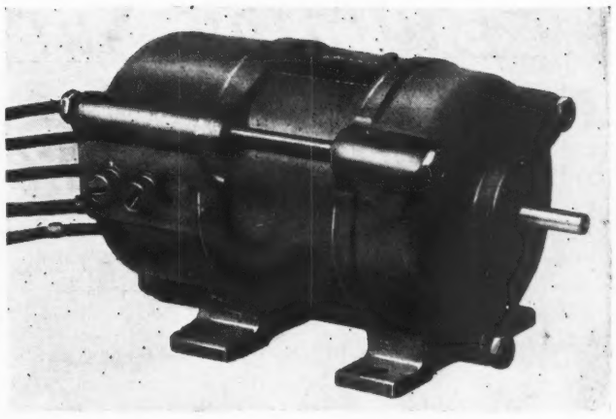


Fig. 4—One of the self-synchronizing motors ("selsyns") used in the signal-system receivers and transmitters

generator whose condition he desires to change. He then turns his transmitter handle to the signal that he desires to communicate. This causes the indicator at the generator to move to the same position.

The generator attendant, upon hearing the bell, will observe the light, go to the generator and turn the handle of the repeat-back transmitter to the signal noted on his indicator. The repeat-back system is identical in operation to the switchboard to generator system except opposite in direction. This provides a complete check on all signals and thereby eliminates any chance of a misunderstanding.

Fig. 3 shows the turbine gage board with "selsyn" indicator *B* and repeat-back transmitter *A*, mounted on it. These gage boards are located at the main units, while a signal pedestal with the same type of transmitter and receiver is located at the generator that supplies the station-service bus. This pedestal is shown at *C*.

In this station there is also a boiler room load indicator which operates on the "selsyn" principle. The totalizing wattmeter shown on the middle section of the left-hand panel, Fig. 2, contains a small transmitter driven by the main shaft of this instrument. This transmitter controls a receiver in an auxiliary indication transmitter which amplifies the torque as received and delivers it to a large transmitter which is connected electrically to the receiver in the large load indicator. Thus the present load pointer of the indicator is automatically driven. The expected demand pointer is operated by another "selsyn" receiver in the same indicator, which in turn is actuated by a manually operated "selsyn" transmitter shown at *C* in the figure.

$2,400 from One Wattmeter

Yearly savings exceeding $2,400 were the direct result of tests made with a portable watt-meter on power equipment in a rubber plant. An article in next week's issue will tell how it was done, for the benefit of progressive engineers in other plants.

Building Surface Condensers By Arc Welding

By Birdsall H. Nichols

THE advantages of arc-welded steel-plate construction would be very pronounced in the building of surface condensers. Greater mechanical strength and less possibility of leakage would be the most obvious results. When making a condenser of iron castings, a number of bolted seams are necessary. These seams are certain to permit some leakage, however carefully machined. A welded steel shell would become as one piece and would have no seams to leak, except of course at the exhaust connection and the tube plates.

The lower first cost is the biggest item in favor of welded steel-plate construction. The elimination of patterns in itself is a big saving owing to the size of the castings required in surface condenser construction and to the fact that condensers must often be made to suit requirements and involve many special patterns. The difficulty and consequent expense of making large castings of thin cross-section is also obviated. The greater strength of steel plate as compared with cast iron makes it possible to save weight and total cost of metal used. The saving of weight is of special importance in marine condensers, hence a condenser with a steel plate shell would have added advantages in marine service.

Fewer machined surfaces, fewer drilled holes, and fewer bolts and nuts would be required. Such surfaces as would require machining could be finished in one light cut. Smaller machine tools could be used than in present condenser shops, as the shell itself would never need to be placed on a planer or boring mill nor under a radial drill. The flanges could be cut from plate, machined on one side, and welded to the shell.

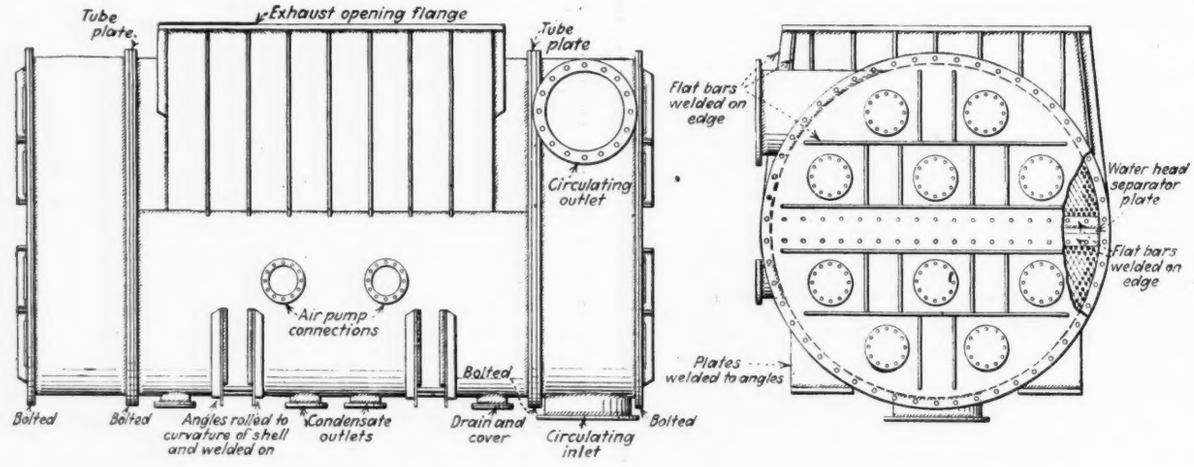
By cutting, forming, and performing the necessary machining operations on the plates and other parts at a factory, and welding them together on the final foundation at the purchaser's plant, great savings in shipping and handling costs could be effected. According to a prominent manufacturer, a train of twenty flat cars is sometimes necessary in order to ship the parts and auxiliary apparatus of one condenser. If this condenser were made of steel plates, less than half this number of cars would suffice.

Since no patterns would be required and machining time would be greatly reduced, condensers with fabricated steel shells could be built in much less time.

Surface condensers of steel-plate construction have been built in England, but the various sections were riveted together. While many of the disadvantages of cast-iron construction were thus obviated, the riveted construction introduced other difficulties. The added weight and expense of riveted construction could be saved by arc welding. The weakening of the plates by rivet holes and the leakage of the riveted joints could be eliminated by using welded joints.

The accompanying drawings represent a typical condenser fabricated by welding. The shell consists of hot-rolled steel plates. The lower two plates are rolled into segments slightly greater than a quarter-circle as shown in the drawing. They are welded together at the bottom. The upper plates, which join them, are flat and tilt slightly to meet the exhaust opening. They are ribbed with flat bars welded on edge. The remainder of the top half of the shell is inclosed by two semicircular plates, and the ends of the exhaust opening are inclosed by flat plates cut to the proper shape.

The exhaust opening flange, which is rectangular, and the circular flanges at each end of the shell are cut from



Condenser fabricated by arc welding is cheaper, lighter and freer from leaks

flat plates by means of an acetylene torch. These flanges are machined on one side and drilled to receive bolts. They are then welded to the shell.

The dry-vacuum-pump connections, the condensate outlets and the bottom drains are made of short pieces of pipe with flanges welded on. These are then welded to the shell at the proper openings, previously cut by means of an acetylene torch.

The water heads are made of plates rolled into segments of semi-circular form welded together at the top and bottom and with flanges welded on each end. The circulating-water inlet and outlet are of welded steel pipe. One end of each is cut off square to receive the flange, and the other end is cut to the proper contour to match the corresponding hole in the water-head casing.

The plate separating the upper and lower compartments of the inlet and outlet water head is welded at each end to the casing. To the top and bottom of this plate are welded flat bars to which the end plates are fastened by means of studs.

The end plates, which are made in halves, are strengthened by flat bars welded on edge as shown in drawing. Openings for cleaning and inspecting the tubes are provided with steel plate covers held in place by studs.

Apparatus such as feed-water heaters, evaporators, distillers, oil coolers, air coolers, and other heat-transfer apparatus could readily be constructed by the methods outlined.

Mr. Birdsall's article was submitted in the Lincoln Arc Welding Prize Contest and is published exclusively in "Power" through the courtesy of the Lincoln Electric Company.—Editor.

Make the Oil Engine Installation Clean

By A. B. Newell

ONE of the most difficult problems in connection with successful oil engine installation work is the complete elimination of dirt. From the time the engine is shipped by the manufacturer until some time after it is put in operation, there is danger of damage resulting from the inadvertent admission of abrasive substances to the working surfaces.

It is surprising to know how few effective precautions are taken to prevent damaging substances from getting into the engine, as compared to the elaborate methods sometimes employed to insure a supply of clean air, oil, fuel and water after the engine is in service.

Probably at no time after the engine is put in service will it be exposed to a condition so dangerous to successful operation as occurs during the first few hours of running. Granting that a certain amount of this danger is unavoidable, much of it is entirely needless and due to ignorance, carelessness or undue haste at the last minute —probably all of these in some instances.

Sometimes we find an engine packed by the manufacturer in the most careful and effective manner only to be torn apart and dragged through sand or mud, one piece at a time, and stored in the open, where the wind may drive dust and sand into every opening. Thereafter more money is spent in cleaning it up and making it ready for assembly than it would have cost to cover it up and keep it clean from the start.

There is no gainsaying that clean and careful methods of installation are the most profitable ones, and there is no single item in connection with such work offering a greater opportunity to exercise this important rule than exists in connection with the work of pipe installation.

The starting air, the fuel and the lubricating oil are all carried to the engine in pipes, and each of these leads to some important working part. Water contamination, which may be the result of not cleaning the pipe, is of less importance since the water does not come in contact with working surfaces and stoppage of the jacket space is less likely than stoppage of the pipes or valves.

We cannot depend on the average pipefitter to realize fully the importance of removing every bit of dirt from the pipe; it is generally essential to the success of the job to have an efficient inspector check up the mechanic. Sometimes it is almost impossible to make a pipe perfectly clean internally, particularly old pipes that are rusty or ones that have been rammed into a sand heap and left for some time. Such pipes should not be used on anything but water service and better not at all.

There is an element of danger even in the use of brand new pipe that has not been pickled to remove the mill scale. The scale will flake off and come along later, but without doing much damage.

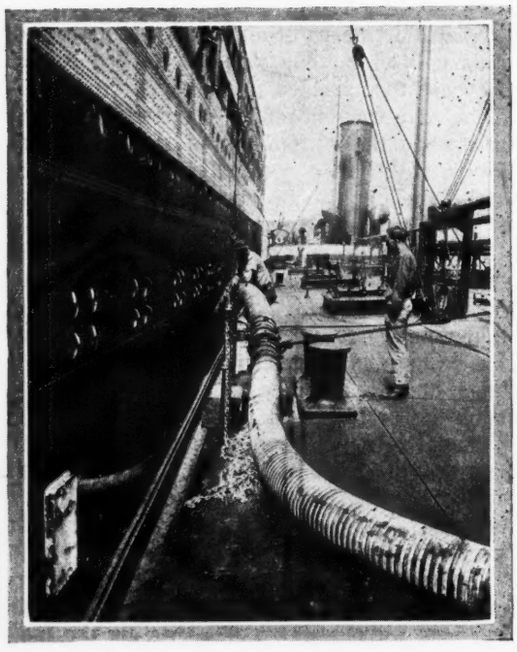
Sometimes we hear an engineer remark that every valve in the engine room leaks and always has leaked, which would indicate that they had been damaged immediately after installation, since new valves seldom leak. This is not surprising in installations where the chip was not reamed out of the end of the pipe after cutting and the pipes later blown clean with compressed air. Time after time we find scraps of cuttings from the pipe dies or cutters lodged in the valves. Sometimes the mechanic drops a fitting in a sand heap, picks it up, gives it a blow with his lips and screws it in place. Obviously, such treatment does not clean it.

On air lines such treatment leads to no end of trouble with the starting valves on the engine. The rush of air under several hundred pounds pressure is terrific, and if it carries along a scrap of steel which strikes a valve or seat, a groove will be made.

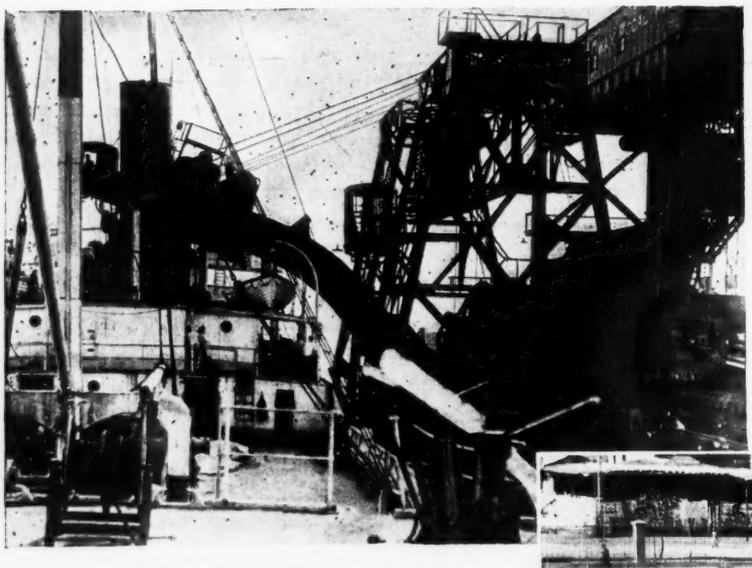
In the fuel system foreign substances may find their way to the fuel pumps and sometimes may cause the plungers to seize and cut badly, after which replacement with new parts is the only remedy. At other times they may cause the fuel pump valves to leak, making it necessary to overhaul the pumps and tune up the engine again, a procedure involving a greater time loss than the extra time required to make a clean installation in the first place.

Finally, the greatest danger lies in the careless installation of lubricating piping. Even when the most careful methods are employed, it is seldom safe to pump oil directly to the bearings of an engine through a new set of pipes. To be perfectly safe every connection should be removed from the bearings and oil should be pumped through the entire system several hours before connecting up. Then oil should be pumped through the bearings while the engine is turned slowly with the jacking gear. These things should be done, even if it is necessary to pump oil and turn the engine by hand. Oil is one of the finest cleansing agents it is possible to use, and since it picks up all the dirt with which it comes in contact, the oil used for cleaning the pipes should not be used again without refiltering.

FUELING SHIPS
In Many Ports

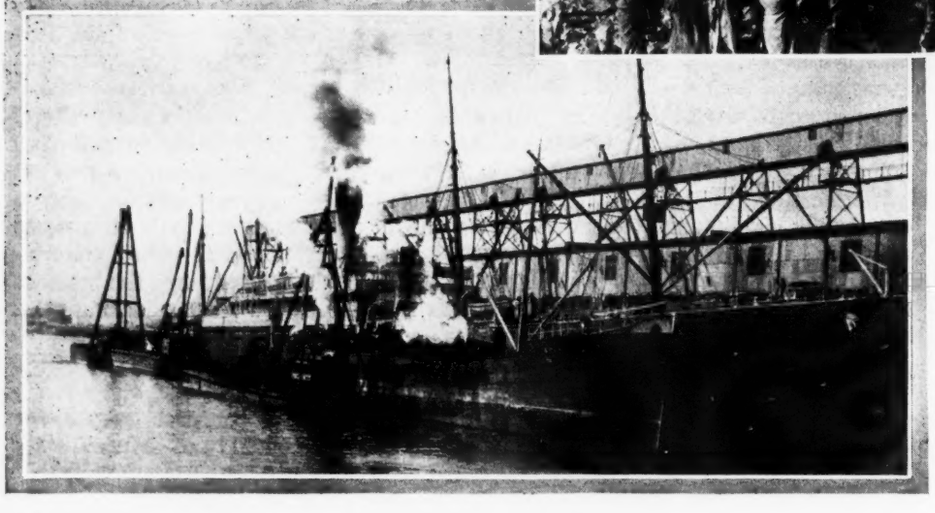


Above—Delivering fuel oil to the "Majestic" at New York



Above—Coaling a steamer at a tide-water station

Below—Coal is loaded on the steamer from barges



Above—At Port Said, the coal is carried on board in baskets by the swarm of natives

What a Pound of Ammonia Will Do

By A. G. Solomon

MANY engineers, when calculating the work done in an ice plant, make errors due to a misapprehension of what the various items in the ammonia tables mean.

The term "heat content" means the heat that has been added to a substance to bring it to a given or understood condition. The heat content of one pound of liquid ammonia or of saturated ammonia vapor is the total heat that has been added to one pound of the liquid or vapor to bring it to the given temperature and pressure.

As a starting point from which to reckon the measurement of the heat addition, 40 deg. below zero F. has been chosen for ammonia, while in case of steam and water the starting point is 32 deg. F. By using this point, —40 deg. F., for ammonia, we avoid the minus quantities in most calculations. Conditions lower than —40 deg. F. are seldom encountered in refrigeration.

The refrigerating effect of one pound of ammonia is the heat, measured in B.t.u., that the ammonia absorbs from the substance to be cooled. But the refrigerating effect of one pound of ammonia is not the same at all times. To obtain the refrigerating effect, it is necessary first to know the heat content of the ammonia under the operating conditions that exist at that time.

It is a common mistake among refrigerating engineers to estimate the heat content as the difference in temperature of the ammonia in two states.

To show how easy it is to make this error, we will take an example and solve it first in the wrong, but common, way and then solve for the correct solution.

What is the refrigerating effect of one pound of ammonia whose temperature is 80 deg. before passing through the expansion valve and which is changed to dry saturated vapor in the evaporating coils at a pressure of 15 lb. gage?

The way many solve the problem is as follows:

The temperature of the saturated vapor at 15 lb. gage pressure is —1 deg. F. The latent heat of evaporation at 15 lb. pressure is 568.9 B.t.u. The difference in temperature of the ammonia in the two states is 81 deg. Subtracting 81 from 569.5 gives 488.5 B.t.u. as the refrigerating effect of one pound of ammonia under the given conditions. This way of figuring is wrong.

To find the correct refrigerating effect, we must first find the heat content of one pound of liquid ammonia at 80 deg. F. This, as will be seen from the ammonia tables, part of which are reproduced in the illustration, is 132 B.t.u.

The heat content of saturated vapor at 15 lb. gage pressure is 611.4 B.t.u. Subtracting, we have 611.4 — 132 = 479.4 B.t.u. This 479.4 B.t.u. is the refrigerating effect of one pound of ammonia evaporated from the liquid at a temperature of 80 deg. to dry saturated vapor at 15 lb. gage pressure and a temperature of minus one.

It means that the one pound of ammonia will absorb 479.4 B.t.u. from the substance to be cooled.

Temp. °F.	Pressure. Absolute. lbs./in.²	Pressure. Gage. lbs./in.²	Volume vapor. ft³/lb.	Density vapor. lbs./ft.³	Heat content. Liquid. Btu./lb.	Heat content. Vapor. Btu./lb.	Latent heat. Btu./lb.	Entropy. Liquid. Btu./lb.°F.	Entropy. Vapor. Btu./lb.°F.	Temp. °F.
t	p	g. p.	V	$1/V$	h	H	L	s	S	t
−10	23.74	9.0	11.50	0.08695	32.1	608.5	576.4	0.0738	1.3558	−10
−9	24.35	9.7	11.23	.08904	33.2	608.8	575.6	.0762	.3537	−9
−8	24.97	10.3	10.97	.09117	34.3	609.2	574.9	.0786	.3516	−8
−7	25.61	10.9	10.71	09334	35.4	609.5	574.1	.0809	.3495	−7
−6	26.26	11.6	10.47	09555	36.4	609.8	573.4	.0833	.3474	−6
−5	26.92	12.2	10.23	0.09780	37.5	610.1	572.6	0.0857	1.3454	−5
−4	27.59	12.9	9.991	1001	38.6	610.5	571.9	.0880	.3433	−4
−3	28.28	13.6	9.763	.1024	39.7	610.8	571.1	.0904	.3413	−3
−2	28.98	14.3	9.541	.1048	40 7	611.1	570.4	.0928	.3393	−2
−1	29.69	15.0	9.326	1072	41.8	611.4	569.6	.0951	.3372	−1
0	30.42	15.7	9.116	0.1097	42.9	611.8	568.9	0.0975	1.3352	0
1	31.16	16.5	8.912	1122	44.0	612.1	568.1	.0998	.3332	1
2	31.92	17.2	8.714	.1148	45.1	612.4	567.3	.1022	.3312	2
3	32.69	18.0	8.521	.1174	46.2	612.7	566.5	.1045	.3292	3
4	33.47	18.8	8.333	.1200	47.2	613.0	565.8	.1069	.3273	4
5	34.27	19.6	8.150	0.1227	48.3	613.3	565 0	0.1092	1.3253	5
6	35.09	20.4	7.971	.1254	49.4	613.6	564.2	.1115	.3234	6
7	35.92	21.2	7.798	.1282	50.5	613.9	563.4	.1138	.3214	7
8	36.77	22.1	7.629	.1311	51.6	614.3	562.7	.1162	.3196	8
9	37.63	22.9	7.464	1340	52.7	614.6	561.9	.1185	.3176	9
10	38.51	23.8	7.304	0.1369	53.8	614.9	561.1	0.1208	1.3157	10
11	39.40	24.7	7.148	.1399	54.9	615.2	560.3	.1231	.3137	11
12	40.31	25.6	6.996	.1429	56.0	615.5	559.5	.1254	.3118	12
13	41.24	26.5	6.847	.1460	57.1	615.8	558.7	.1277	.3099	13
14	42.18	27.5	6.703	.1492	58.2	616.1	557.9	.1300	.3081	14
15	43.14	28.4	6.562	0.1524	59.2	616.3	557.1	0.1323	1.3062	15
16	44.12	29.4	6.425	.1556	60.3	616.6	556.3	.1346	.3043	16
17	45.12	30.4	6.291	.1590	61.4	616.9	555 5	.1369	.3025	17
18	46.13	31.4	6.161	.1623	62.5	617.2	554.7	.1392	.3006	18
19	47.16	32.5	6.034	.1657	63.6	617.5	553.9	.1415	.2988	19
20	48.21	33.5	5.910	0.1692	64.7	617.8	553.1	0.1437	1.2969	20
21	49.28	34.6	5.789	.1728	65.8	618.0	552.2	.1460	.2951	21
22	50.36	35.7	5.671	.1763	66.9	618.3	551.4	.1483	.2933	22
23	51.47	36.8	5.556	.1800	68.0	618.6	550.6	.1506	.2915	23
24	52.59	37.9	5.443	.1837	69.1	618.9	549.8	.1528	.2897	24
25	53.73	39.0	5.334	0.1875	70.2	619.1	548.9	0.1551	1.2879	25
26	54.90	40.2	5.227	.1913	71.3	619.4	548.1	.1573	.2861	26
27	56.08	41.4	5.123	.1952	72.4	619.7	547.3	.1596	.2843	27
28	57.28	42.6	5.021	.1992	73.5	619 9	546.4	.1618	.2825	28
29	58.50	43.8	4.922	.2032	74.6	620.2	545.6	.1641	.2808	29
30	59.74	45.0	4.825	0.2073	75.7	620.5	544.8	0.1663	1.2790	30
31	61.00	46.3	4.730	.2114	76.8	620.7	543.9	.1686	.2773	31
32	62.29	47.6	4.637	.2156	77.9	621.0	543.1	.1708	.2755	32
33	63.59	48.9	4.547	.2199	79.0	621.2	542.2	.1730	.2738	33
34	64.91	50.2	4.459	.2243	80.1	621.5	541.4	.1753	.2721	34
35	66.26	51.6	4.373	0.2287	81.2	621.7	540.5	0.1775	1.2704	35
36	67.63	52.9	4.289	.2332	82.3	622.0	539.7	.1797	.2686	36
37	69.02	54.3	4.207	.2377	83.4	622.2	538.8	.1819	.2669	37
38	70.43	55.7	4.126	.2423	84.6	622.5	537.9	.1841	.2652	38
39	71.87	57.2	4.048	.2470	85.7	622.7	537.0	.1863	.2635	39
40	73.32	58.6	3.971	0.2518	86.8	623.0	536.2	0.1885	1.2618	40

Temp. °F.	Pressure. Absolute. lbs./in.²	Pressure. Gage. lbs./in.²	Volume vapor. ft³/lb.	Density vapor. lbs./ft.³	Heat content. Liquid. Btu./lb.	Heat content. Vapor. Btu./lb.	Latent heat. Btu./lb.	Entropy. Liquid. Btu./lb.°F.	Entropy. Vapor. Btu./lb.°F.	Temp. °F.
t	p	g. p.	V	$1/V$	h	H	L	s	S	t
40	73.32	58.6	3.971	0.2518	86.8	623.0	536.2	0.1885	1.2618	40
41	74.80	60.1	3.897	.2566	87.9	623.2	535.3	.1908	.2602	41
42	76.31	61.6	3.823	.2616	89.0	623.4	534.4	.1930	.2585	42
43	77.83	63.1	3.752	.2665	90.1	623.7	533.6	.1952	.2568	43
44	79.38	64.7	3.682	.2716	91.2	623.9	532.7	.1974	.2552	44
45	80.96	66.3	3.614	0.2767	92.3	624.1	531.8	0.1996	1.2535	45
46	82.55	67.9	3.547	.2819	93.5	624.4	530.9	.2018	.2519	46
47	84.18	69.5	3.481	.2872	94.6	624.6	530.0	.2040	.2502	47
48	85.82	71.1	3.418	.2926	95.7	624.8	529.1	.2062	.2486	48
49	87.49	72.8	3.355	.2981	96.8	625.0	528.2	.2083	.2469	49
50	89.19	74.5	3.294	0.3036	97.9	625.2	527.3	0.2105	1.2453	50
51	90.91	76.2	3.234	.3092	99.1	625.5	526.4	.2127	.2437	51
52	92.66	78.0	3.176	.3149	100.2	625.7	525.5	.2149	.2421	52
53	94.43	79.7	3.119	.3207	101.3	625.9	524.6	.2171	.2405	53
54	96.23	81.5	3.063	.3265	102.4	626.1	523.7	.2192	.2389	54
55	98.06	83.4	3.008	0.3325	103.5	626.3	522.8	0.2214	1.2373	55
56	99.91	85.2	2.954	.3385	104.7	626.5	521.8	.2236	.2357	56
57	101.8	87.1	2.902	.3446	105.8	626.7	520.9	.2257	.2341	57
58	103.7	89.0	2.851	.3508	106.9	626.9	520.0	.2279	.2325	58
59	105.6	90.9	2.800	.3571	108.1	627 1	519.0	.2301	.2310	59
60	107.6	92.9	2.751	0.3635	109.2	627.3	518.1	0.2322	1.2294	60
61	109.6	94.9	2.703	.3700	110.3	627 5	517.2	.2344	.2278	61
62	111.6	96.9	2.656	.3765	111.5	627.7	516.2	.2365	.2262	62
63	113.6	98.9	2.610	.3832	112.6	627.9	515.3	.2387	.2247	63
64	115.7	101.0	2.565	.3899	113.7	628.0	514.3	.2408	.2231	64
65	117.8	103.1	2.520	0.3968	114.8	628.2	513.4	0.2430	1.2216	65
66	120.0	105.3	2.477	.4037	116.0	628.4	512.4	.2451	.2201	66
67	122.1	107.4	2.435	.4108	117.1	628.6	511.5	.2473	.2186	67
68	124.3	109.6	2.393	.4179	118.3	628.8	510.5	.2494	.2170	68
69	126.5	111.8	2.352	.4251	119.4	628.9	509.5	.2515	.2155	69
70	128.8	114.1	2.312	0.4325	120.5	629.1	508.6	0.2537	1.2140	70
71	131.1	116.4	2.273	.4399	121.7	629.3	507.6	.2558	.2125	71
72	133.4	118.7	2.235	.4474	122.8	629.4	506.6	.2579	.2110	72
73	135.7	121.0	2.197	.4551	124.0	629.6	505.6	.2601	.2095	73
74	138.1	123.4	2.161	.4628	125.1	629.8	504.7	.2622	.2080	74
75	140.5	125.8	2.125	0.4707	126.2	629.9	503.7	0.2643	1.2065	75
76	143.0	128.3	2.089	.4786	127.4	630.1	502.7	.2664	.2050	76
77	145.4	130.7	2.055	.4867	128.5	630.2	501.7	.2685	.2035	77
78	147.9	133.2	2.021	.4949	129.7	630.4	500.7	.2706	.2020	78
79	150.5	135.8	1.988	.5031	130.8	630.5	499.7	.2728	.2006	79
80	153.0	138.3	1.955	0.5115	132.0	630.7	498.7	0.2749	1.1991	80
81	155.6	140.9	1.923	.5200	133.1	630.8	497.7	.2769	.1976	81
82	158.3	143.6	1.892	.5287	134.3	631.0	496.7	.2791	.1962	82
83	161.0	146.3	1.861	.5374	135.4	631.1	495.7	.2812	.1947	83
84	163.7	149.0	1.831	.5462	136.6	631.3	494.7	.2833	.1933	84
85	166.4	151.7	1.801	0.5552	137.8	631.4	493.6	0.2854	1.1918	85

Properties of Ammonia

In this example it will be noticed that there is a great difference in the heat content of the liquid and the dry saturated vapor. This shows plainly that the vapor has absorbed heat or it would not be vapor but liquid. Heat must be taken up by liquid ammonia to change its state to vapor.

Take the following for another example:

How much heat is needed to change one pound of liquid ammonia at a temperature of 80 deg. into dry saturated vapor at the same temperature?

The heat content of the liquid is 132 B.t.u.; the heat content of the vapor is 630.7 B.t.u. The latent heat of evaporation is 498.7 B.t.u. as seen from the tables. The difference between 630.7 and 132 is 498.7 B.t.u., which is just the same as the latent heat of evaporation. This shows that as there is no change in temperature, it requires exactly the latent heat of evaporation to change one pound of liquid into one pound of dry saturated vapor. The word "latent" in "latent heat" refers to heat that does not appear as a change in temperature.

The liquid ammonia that passes through the expansion valve has a certain amount of heat content, depending upon its temperature. Some of this heat in the liquid at the high pressure serves to evaporate part of the liquid as it goes into the low-pressure coil. Some part of the ammonia is therefore really used in taking the heat from itself.

Heat from the substance to be cooled will not flow to the ammonia till the temperature of the ammonia is lower than the temperature of the substance to be cooled.

If this work goes on in the coils of an ice tank or of a direct expansion system, it is evident that some part of the coil surface is being used as the place to get the ammonia ready to take heat from the ice-tank brine or the atmosphere of the cold-storage room.

For this reason the precooling of the liquid ammonia is resorted to in many plants. By the precooling of the ammonia before it passes the expansion valve, the heat content is reduced and the liquid in evaporating must take up its latent heat from the brine. The absorption of heat in useful work is increased; the closer the temperature of the liquid to the temperature of the vapor in the evaporating coils the more efficient is the surface of the evaporator. Also, the higher the pressure maintained in the evaporator the greater is the heat content of the saturated vapor, which means that more B.t.u. are being taken up.

Then, to obtain the greatest efficiency from the ammonia system, the temperature of the ammonia passing through the expansion valve must be as low as possible and the pressure in the evaporator must be as high as can be carried and still maintain a proper temperature difference between the substance to be cooled and the evaporating ammonia.

The pressure in the evaporator will depend on the amount of heat that must be taken up per square foot of coil surface. If an ice tank has 300 lin.ft. of $1\frac{1}{4}$-in. pipe per ton of ice made in 24 hours and the evaporator pressure is 20 lb. gage, the addition of more coil surface would allow a higher pressure to be carried.

Improvements in Draft Tube

Result in Large Savings

By J. Jacobs

IN THE operation of a hydro-electric station the question of an efficient design of draft tube and tailrace is just as important as that of efficient design of condensing equipment for a steam turbine. Among our group of water-power plants we have one that is of an old design. However, the unit treated in this article was installed in 1910, which is evidence that improved draft-tube design is a product of comparatively recent years. The draft tube on this unit had been causing trouble, and it was decided to make some changes in the design.

In Fig. 1 the original floor plan of the plant is indicated in solid lines and the new extension to the building is shown in dotted lines. At the point marked *A* the weight of the building was carried by steel I-beams resting on the concrete pier at one end of the short tailrace division wall between units 5 and 6.

Owing to absence of tailrace division wall at *A* the turbulent discharge of No. 6 unit continually swept over into the tailrace of No. 5. This was undesirable, as it tended to reduce the effective head of this machine, besides undoubtedly contributing to erosion of the base of the pier, which was later discovered when making soundings. Improvements carried out at this time included completion of this division wall and repairs to the base of the concrete pier.

As indicated in heavy lines in Fig. 2, the original draft tube was slightly conical and inclined to the angle shown.

The turbulent condition of the water emerging from the draft tube of this particular unit gave rise to the suspicion that all was not well down on the tailrace floor. Further investigation developed that the draft tube was vibrating considerably, due in part possibly to this turbulent condition of the water as well as to the poor method of support, which was nothing more than suspending a part of the weight of the draft tube from the crown of the arch as shown. We also noted that the unit, although of 1,500 kw. normal capacity and operating under the head designed for, could develop only about 1,300 kw. under the best of conditions.

While working up estimates for the probable cost of cofferdamming, we made a few soundings in the tailrace, there being no blueprints to give any idea of what the tailrace floor looked like. It was then that we discovered the poor condition at the base of the pier. This was

somewhat alarming, as we planned to extend the building to make room for additional transformers. This turned out to be a blessing in disguise in that it hastened our decision with respect to improvements to the draft tube and tailrace for the 1,500-kw. unit.

To prevent the draft tube from vibrating, it was incased in a concrete block resting on rock foundation. After the rock had been removed from the floor of the tailrace, the concrete was extended along this floor to give a smooth sweeping curve out to the building line. The original line of the rock across the tailrace floor is shown by the dotted profile lines. By adding the long curved extension to the lower end of the draft tube, it becomes necessary, to prevent restriction of the flow, to cut away the portion of the tube indicated by the shaded area. A concrete diffusion apron was added to the end, as indicated.

The improvised elbow added to the end of the draft tube served to ease the column of water away and practically eliminated all turbulence of the water in the tailrace.

The center line of the waterwheel is 25 ft. above normal tailwater level, resulting in an excessive total draft head, which is conducive to rapid corrosion and pitting of the runners. With an excessive total draft head the column of water in the draft tube also tends to break and cause vibration. As we had previously experienced difficulty in maintaining the draft tube rigid, it was decided to concrete around the tube as shown, which solved this part of the problem.

The changes made in the design of the draft tube and tailrace have not in any way reduced the objectionably excessive draft head. Doubtless it has increased it because the runners are pitting at a greater rate than formerly, and once a year it will be necessary to build up the spots that corrode, by electric welding, to maintain the runners in good condition.

The total cost of cofferdamming and repairs to the base of the building pier, cleaning out rock and concreting the draft-tube extension as indicated in the drawing was about $10,000. Other charges included $500 a year for welding, which should not all be charged against this work because pitting was already in progress. Capacity loss by having the unit out of service is not considered, because the welding is done at the time of the annual inspection.

The capacity of the unit was increased from 1,300 to 1,525 kw. This increase was of much greater moment in this particular plant, because, although the plant was the farthest down stream, it had the least capacity of all stations on the river, consequently water was going to waste most of the time. The load factor for this plant was about 75 per cent. Assuming the average increase in capacity to be 200 kw., which was sold at a minimum of one cent per kilowatt-hour, the net saving is approximately $1,000 a month, or $12,000 a year. Even if we assumed that this saving should be considered as applying only over a period of six months, the cost of the improvement would still be a very reasonable investment, because only one-half of the total cost should be charged to draft-tube improvement—the building and pier account ing for the other half. As we have to supplement hydr

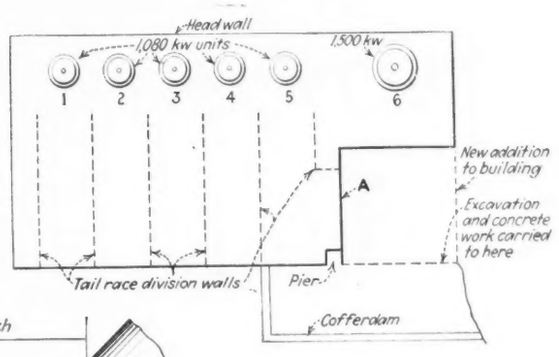


Fig. 1 (Above) — Plan of the generator room floor and the extension to the building

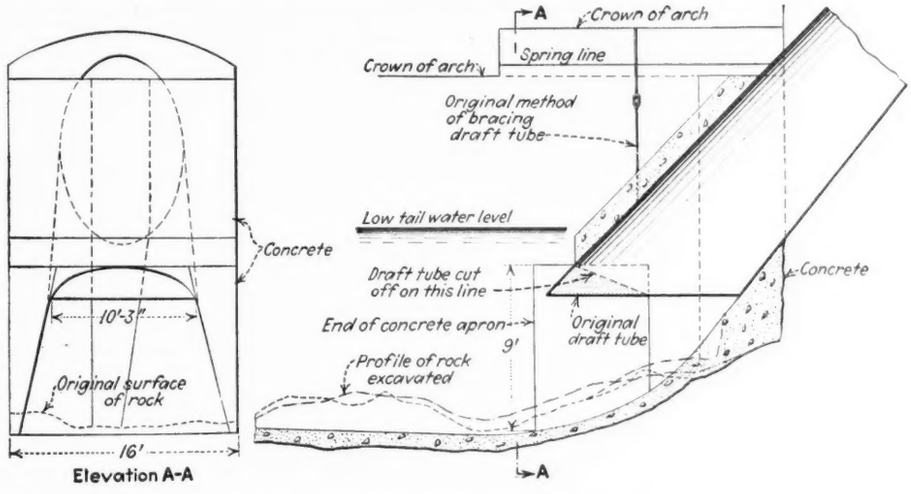


Fig. 2 (Left) — Section through the draft tube showing the changes that were made. The rock was removed and the concrete added

with steam during the summer time and we are in a position to sell dump power at a low rate during the high stages of the river, the improvements outlined are resulting in a substantial saving throughout the year.

The cost of welding the runners may appear high and is probably given higher than it actually will be. The design of these runners is such that corrosion and pitting take place not only at the curved portion at the draft-tube end of the runner, but also higher up in the sharp angle between the bucket and the band. This makes it difficult both for welding and grinding the surfaces. In fact, grinding is next to impossible, because there is not sufficient room for operating the grinding wheels, and we were forced to resort to the use of long chisels to clean off the surface.

Another reason for the apparently excessive cost is due to the fact that in the case of a large wheel it is a simple matter to get inside and set up the necessary staging and proceed with the work, as it involves only the removal of a manhole plate. For our small unit it is necessary to unbolt and lift off a heavy top casing. The space for this operation is restricted and at best it is an awkward job. This also involves making up large gaskets and tightening up a large number of casing bolts.

Novel Features of

THE SUN TWO CYCLE DIESEL

By L. H. MORRISON
Associate Editor

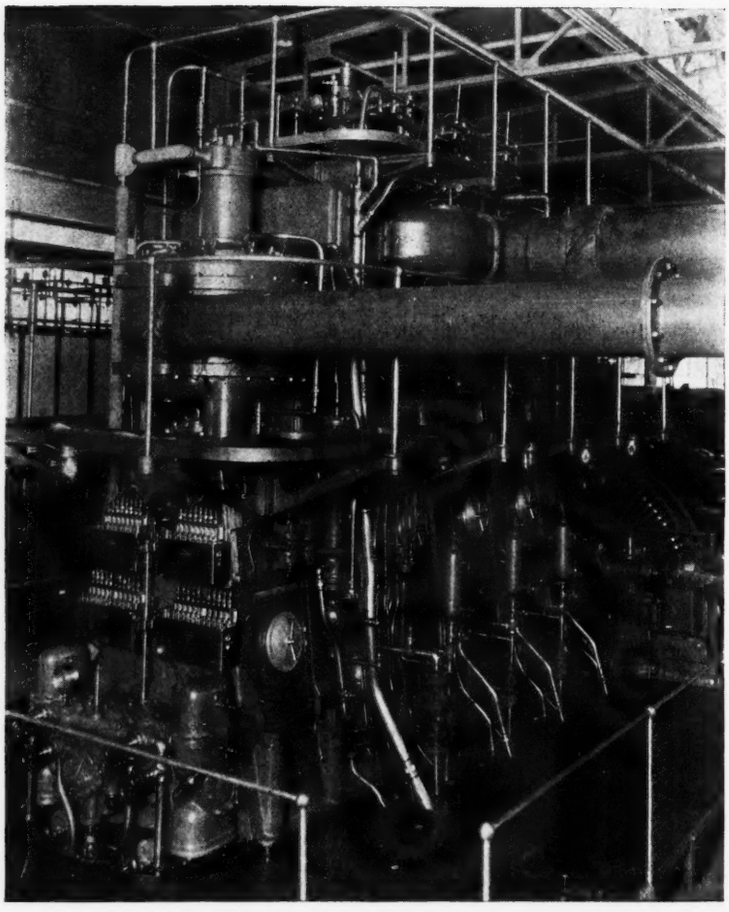


Fig. 1—The Sun double-acting two-cycle Diesel

A DOUBLE-ACTING two-stroke cycle air-induction Diesel delivering 300 horsepower per cylinder has been developed by the Sun Shipbuilding & Dry Dock Company, Chester, Pa. While the design embraces many features that have become standard through years of use, the engine has several details that are novel and of merit.

The inherent advantages of the double-acting principle lies in the small size of cylinder for a given power. This leads to a reduced weight and, therefore, a lower production cost. For large powers this line of reasoning has prompted the almost exclusive use of the double-acting Diesel, but for units of less than 3,000 hp. designers are not in agreement.

Undoubtedly, the cheapest design is the trunk-piston, as this results in an engine of lower headroom and less cost than the crosshead design. When, however, the cylinder size is such that piston cooling is necessary, the crosshead design must be adopted, even at the increased cost.

If the crosshead type engine be made double-acting, compared to the single-acting design, there is an increase in the cylinder height, a lower cylinder head, a stuffing box and additional valve gear. The cost of these parts is small compared to the power gained.

When initiating the design, the Sun engineers decided upon a cylinder of 16-in. bore and 22-in. stroke, to run at from 165 to 180 r.p.m. The experimental unit had but a single cylinder, but the bedplate was arranged to accommodate three cylinders. Injection and scavenging air was obtained from an outside compressor, but after the successful tests the other two cylinders and a combined compressor and blower were added to complete the machine.

The three-cylinder unit was tested at full load with independent auxiliaries and gave the results shown in the tabulation.

RESULTS OF TESTS

Indicated horsepower	966
Brake horsepower	861
Mechanical efficiency, per cent	90
Mean indicated pressure, lb.	83.2
Exhaust temperature, deg. F.	354
Water-inlet temperature, deg. F.	42
Water outlet from cylinders, deg. F.	130
Water inlet for pistons, deg. F.	100
Injection-air pressure, lb. per sq.in.	960
Scavenging-air pressure, lb. per sq.in.	2.23
Fuel consumption, lb per b.hp.-hr.	0.415
Fuel consumption, lb. per i.hp.-hr.	0.360
Over-all thermal efficiency, per cent	33.7

The mechanical efficiency at the beginning of the run was 85 per cent; after one and one-half hours it reached 89.5 per cent, and toward the end of the third hour, 90 per cent. In other words, the friction of the bare engine was only 10 per cent.

The engine as viewed from the exhaust side, is shown in Fig. 1; a cross-section appears in Fig. 4.

It will be observed from the illustrations that each cylinder assembly is supported on two A frames. The cylinder assembly is made up of an upper cylinder jacket and an exhaust belt and a lower cylinder jacket. These

three castings are held together by turned bolts having enlarged bodies, so that the bolts act not only to hold the parts together, but also as separators so that the positions of the parts are fixed. The lower ends of the bolts pass through the upper part of the A frames and are secured by nuts. Contrary to a general practice these rods do not transmit the working stresses to the bedplate; the designers claim that if the A frames are heavy enough to give the necessary rigidity, they are amply strong to withstand the working tension.

Within the two jackets are inserted the liners, which join at the exhaust belt with a male-and-female joint. There is enough clearance at this point to care for all the elongation occurring when the engine warms up.

The upper cylinder head is a plain cored steel casting without internal ribs and with but two openings, one for the centrally placed fuel-spray valve and the other for the off-center air-starting valve. The lower cylinder head is of two-piece construction and is designed to have the cylinder clearance volume massed at one side of the rod. The lower spray valve is placed horizontally, with two divergent spray openings.

The outstanding feature of the cylinder design is the arrangement of the scavenging and exhaust ports. As shown in Figs. 4 and 6, the scavenging ports are placed about one-half of the cylinder circumference, the other half being taken up by the exhaust ports. Cages hold steel strips which act as the air valves. These strips remain seated until the piston has uncovered the exhaust slots and the cylinder pressure has dropped to below two to three pounds, this pressure being that carried in the scavenging air compartment. When this pressure is reached, the valves open without delay and the scavenging air flows out and passes along the proper deflectors into the cylinder.

The use of this deflector design enables the designer to use but one row of parts and to reduce the length of the cylinder and of the piston. Owing to the narrowness of the valve openings, the load on the valves is small and the thin steel strips work satisfactorily and respond to a minute pressure difference. This leads to a reduction in the power needed by the air pump.

The scavenging air chamber is obtained by inclosing the space between the upper and lower jackets by light aluminum plates.

The scavenging air is supplied by a double-acting pump arranged below the cylinders of the injection-air compressor, Fig. 3, both being served by a common connecting rod and crank.

Air injection was adopted in preference to solid injection of the fuel by reason of the shape of the lower combustion space. The designers were convinced that

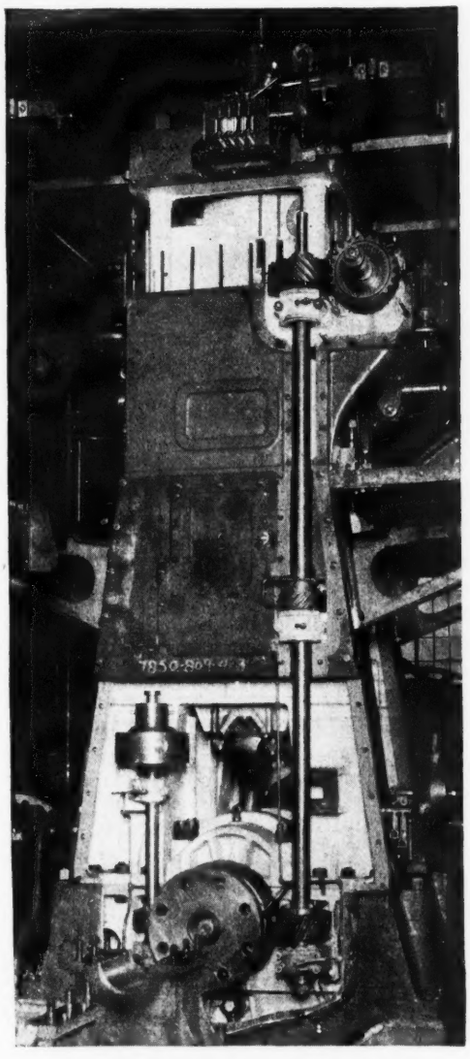


Fig. 2—The flywheel end of the engine

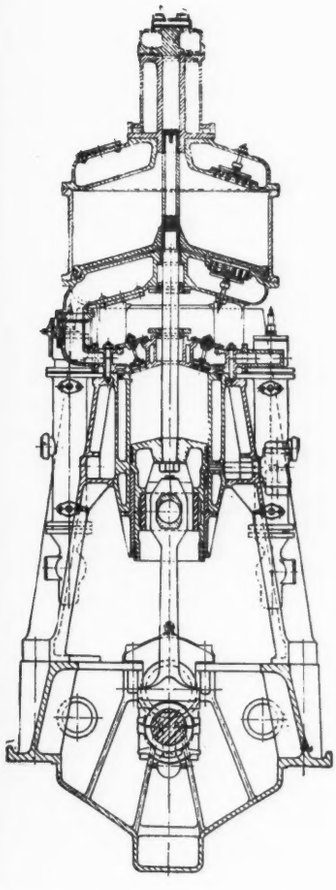


Fig. 3—Section through the compressor

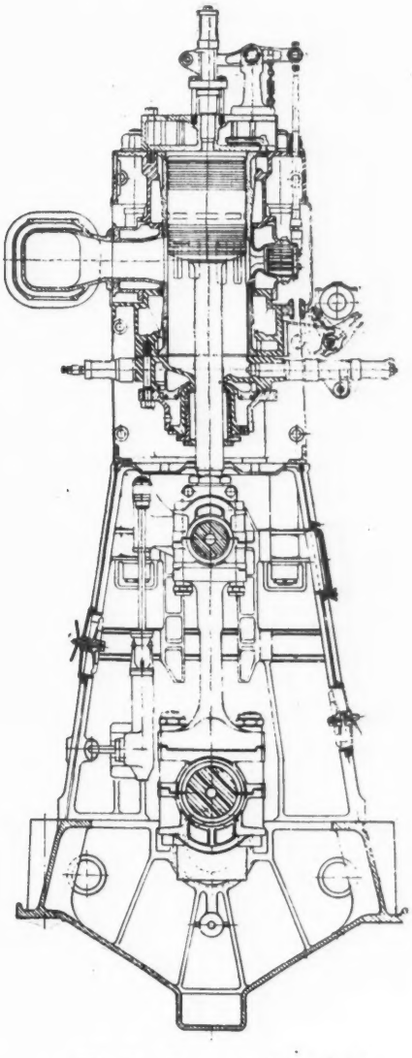


Fig. 4—Cross-section of the engine

the air would distribute the fuel better than would pump pressure.

Each end of the cylinders has its individual fuel pump, which is cam-driven by the camshaft and is governed by control of the pump suction valve closure. The camshaft is driven from the crankshaft through a vertical shaft and helical gears. For each cylinder the camshaft carries one air-starting cam and one spray-valve cam, the rocker rollers for the two ends working on the one cam.

The amount of labor involved in the manufacture of this engine is from 30 to 50 per cent less than that of the engines now currently produced in the United States, so it is claimed. This saving is due mostly to a reduction of the expensive erection work, thus materially shortening the time one of these engines remains in the shop, which means less operating capital and quicker turnover.

With the exception of slight variations in the control gear the construction of the engine is completely standardized to meet with equal facility the requirements of stationary and marine operation. An unusually wide range of capacities can be covered with one cylinder size at a minimum investment for patterns, tools and fixtures.

The smaller and fewer bearings and other rubbing surfaces perceptibly reduce the friction loss and the lubricating oil consumption is correspondingly low. As a marine engine its shorter length renders it less susceptible to the unavoidable elastic deformations of the hull, and therefore less likely to develop bearing trouble.

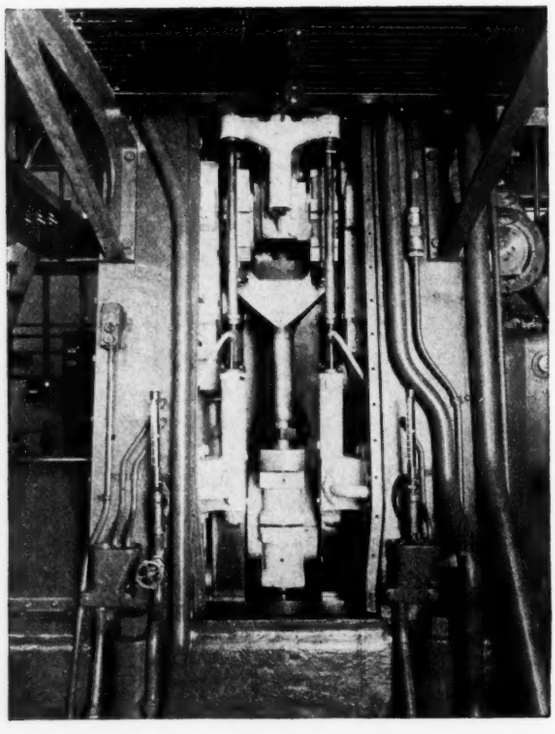


Fig. 5—Connecting rod and telescopic tubes

Effective lubrication is facilitated by virtue of the fact that the pressures on all main bearings, crank and crosshead-pin boxes and guides reverse at least twice in every revolution. Contamination of the lubricating oil in the crankcase by residues from the engine cylinders is prevented by an additional stuffing box in a suitably fitted diaphragm placed below the main stuffing box.

The elimination of dangerous stresses in the cylinder heads is safeguarded by a form which promotes ease of molding and soundness of castings, freedom from excessive initial casting strains, and uniform wall sections. Their construction is such as to avoid bending stresses when bolted up, and the flow of cooling water is directed over the essential wall surfaces.

The piston construction comprises only three parts, all of them of such form as to permit the use of thin walls and effective water cooling over the entire length, including the piston-ring seats. All the joints are provided with double protection against corrosion, rusting and leaks. Both ends of the cylinder can be readily opened up for inspection, and the piston can be removed with equal facility from above or below.

Starting and reversing of the engine is facilitated by means of a timed compression relief, which conduces to low starting-air pressures and economical use of starting air. This feature not only simplifies the auxiliary apparatus needed with every Diesel engine, but it adds to the safety of operation in precluding any high-temperature gases passing from the engine cylinders to the starting air receiver.

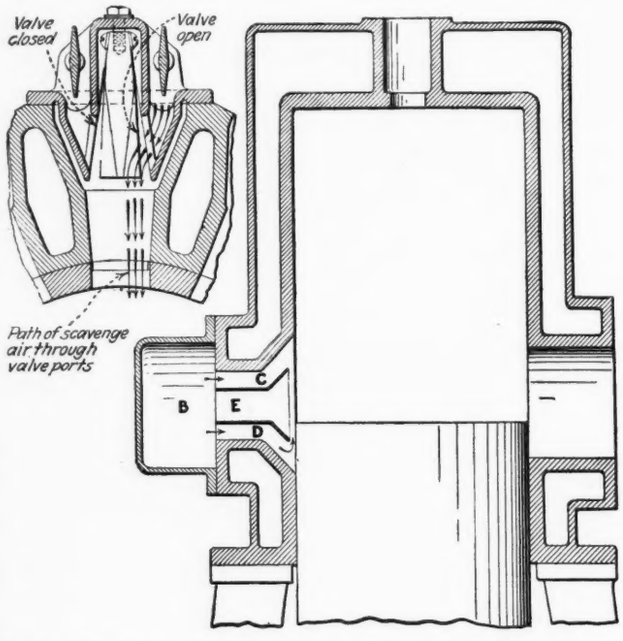


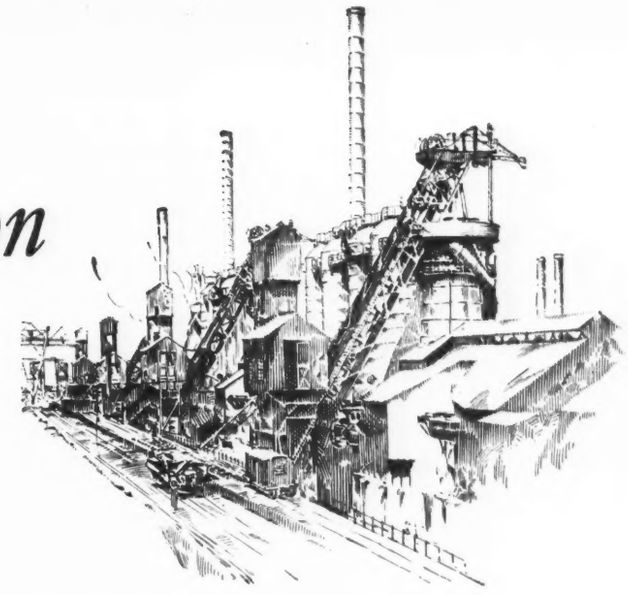
Fig. 6—The scavenging air valves and direction of flow

The basic idea of the engine was originated by the late H. R. Setz and was developed by J. Barraja-Frauenfelder and Sun engineers, including W. Johnson, Jr.

SELLING METERS TWICE

Meters must be sold twice—first to the purchaser and then to the real user. The engineer who buys meters must "sell" them to his operating force if he is looking for results. Read what M. J. Hess has to say about it in the Sept. 18 issue.

Prepared Fuels From Gasification of Coal *



By A. A. Potter and H. L. Solberg

Dean of Engineering, Purdue University — *Ass't Prof. of Mechanical Engineering, Purdue University*

Producer gas, blast-furnace gas, blue water gas and carbureted water gas—What they are, how they are made and what they are used for.

THE manufacture of prepared fuels from coal is justified where (1) the coal is of such poor quality that it cannot well be utilized directly, (2) the prepared fuel is used in applications for which the raw coal is not adaptable, (3) the efficiency of utilization is sufficiently higher than that of the raw coal to pay for the cost of preparation, and (4) the value of the prepared fuel and the byproducts is in excess of the cost of the raw coal plus the cost of preparation.

At present, about 15 per cent of the coal mined in the United States is subjected to some form of gasification, destructive distillation or other treatment. The applications of prepared fuels for the generation of power are limited. The power required to operate the steel mills is generally produced in part or completely from the blast furnace gas which is a byproduct of the manufacture of pig iron. One of the principal reasons for the interest shown by power-plant engineers in the fuel processing problem is the growing belief that the power plant of the future will be combined with the fuel processing plant in order to extract the valuable byproducts of coal and burn the residue for the generation of power. In fact, experimental work along this line is now being conducted by at least one central-station company.

There are two methods of treating coal to produce prepared fuels, in extensive use at present. These are (1) complete gasification and (2) carbonization of coal. Several other methods are undergoing development and give promise of radically changing our existing ways of utilizing coal. However, they are still in the experimental stage.

In the complete gasification of coal the object is to burn the fuel partly, thereby producing a combustible gas which can be burned elsewhere. Under ideal conditions the carbon is burned to CO, the water is decomposed to hydrogen and oxygen, and the hydrocarbons are decomposed to CO, H_2 and the simpler hydrocarbons such as CH_4, C_2H_6, etc. These reactions are brought about by incomplete combustion due to insufficient air. Since combustion occurs in two steps, there are two sets of losses, and more equipment is required than is necessary to effect complete combustion of the fuel in one step. Because of the lower efficiency of combustion and the cost of producing the fuel, the gases generated by complete gasification are used mainly in industrial applications and as a substitute for natural gas.

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Producer Gas

A gas producer (see illustration) consists essentially of a brick-lined chamber containing a fuel bed four or five feet in depth. Fresh coal is charged in at the top and air is supplied at the bottom of the producer. There are four zones in the fuel bed. The lower zone is composed of ash and clinker. The second is an oxidizing zone in which the incandescent carbon unites with the oxygen of the incoming air and burns to carbon dioxide, with the generation of 14,560 B.t.u. per pound of carbon burned.

The products of combustion formed in the oxidation zone pass upward into the reduction zone where the CO_2, in the absence of oxygen and at the high fuel-bed temperatures, is reduced to CO in passing over the hot carbon in the fuel bed. The reactions which take place are as follows:

Oxidizing zone:

$$C + O_2 + 3.76\,N_2 = CO_2 + 3.76\,N_2 \qquad (1)$$

Reducing zone:

$$CO_2 + C + 3.76\,N_2 = 2\,CO + 3.76\,N_2 \qquad (2)$$

The gas produced according to the above reactions in the reducing zone has an analysis, by volume, of 34.7 per cent CO and 65.3 per cent N_2, with a heating value of about 110 B.t.u. per cubic foot. One cubic foot of CO has a heating value of about 324 B.t.u., but the presence of 65.3 per cent of inert nitrogen in the gas results in a gas of low heating value. As this nitrogen is supplied with the oxygen as air, its presence is unavoidable.

A certain amount of CO_2 will be present in the gas leaving the producer due to incomplete reduction of CO_2

to CO and to leakage of air into the producer at the top, through holes in the fire and along the walls of the producer.

If a producer is supplied with air only, the temperatures becomes so high in the lower part of the fuel bed that the ash will fuse and form troublesome clinker. In order to overcome this difficulty, it is necessary to introduce a certain amount of steam with the air. It is necessary to limit the amount of steam introduced in order to prevent too great a reduction in fuel-bed temperatures. Best results are obtained when from 0.35 to 0.40 of a pound of steam is used per pound of coal.[1] Sometimes it is necessary to increase this to as high as 0.60 lb. of steam.

In passing upward through the distillation zone, the hot gases give up some of their sensible heat to the fresh coal and drive off the volatile hydrocarbons in the form of tars. For best results, the gases leave the producer at about 1300 deg. F., at which temperature the tars are in the form of vapors. As the gas is cooled in the mains, the tars condense and may cause serious trouble unless removed. If the gas is used in a gas engine, it is essential that it be freed from gritty material that would score the cylinders, and that the tarry material be eliminated to prevent clogging of the valves and governor. Cleaning of the gas may be effected by bubbling through water, by the use of filters or by passing through scrubbers. Because of the difficulty of completely removing the tars from the gas, anthracite coal or coke is generally used as producer gas fuel if the gas is to be used in a gas engine. In most other cases the fuel is a non-caking bituminous coal, preferably one in which the ash has a high fusing temperature.

Table I shows the average analysis of producer gas obtained from bituminous coal, the values reported being

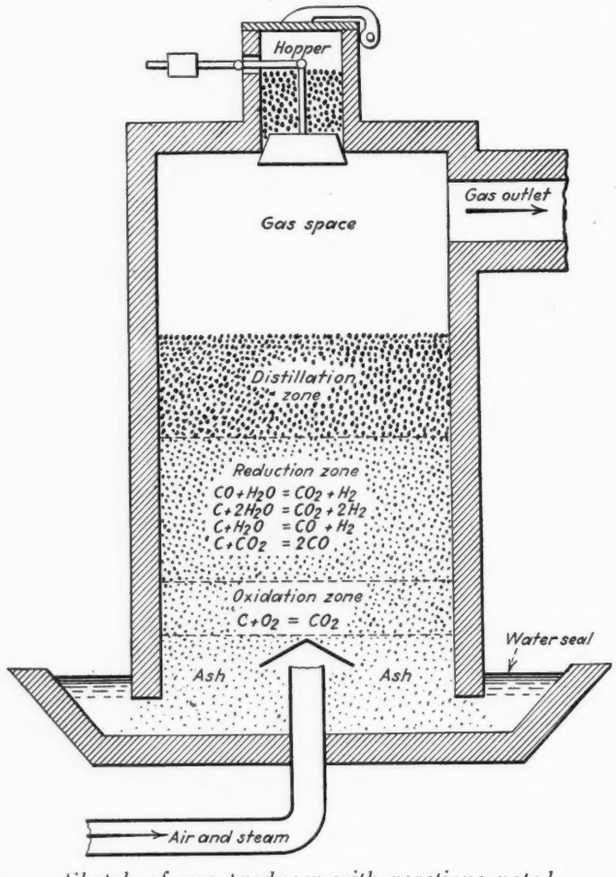
TABLE I—AVERAGE COMPOSITION OF PRODUCER GAS FROM BITUMINOUS COAL

B.t.u. per lb. of coal	12,372
Cu. ft. of gas per lb. of coal	61.1
B.t.u. per cu. ft. of standard gas	150.9
Carbon dioxide	9.71
Oxygen	.02
Ethylene (C_2H_4)	.19
Carbon monoxide	19.03
Hydrogen	13.48
Methane (CH_4)	2.78
Nitrogen	54.79

the average of 112 tests reported in Bulletin 13 of the United States Bureau of Mines. The principal commercial applications of producer gas are in gas engines, in lime burning, in the glass and ceramic industries, and in metallurgical furnaces.

Blast Furnace Gas

The blast furnace is a large gas producer. Coke, iron ore and limestone are charged in at the top and the air necessary for combustion of the coke is supplied under pressure at the bottom. The carbon is burned to CO at the high temperatures encountered at the bottom of the fuel bed. Some CO_2 and CO are also produced by the reduction of the charge of limestone, ore and impurities. Moisture present in the air supplied to the furnace is decomposed to hydrogen and oxygen. From 133,000 to 150,000 cu.ft. of gas is produced per ton of iron in a modern blast furnace.[2] Its heating value is about 95 B.t.u. per cubic foot and represents about 50 per cent of the original heating value of the coke. About 30 per cent of this gas is burned in stoves to heat the air supplied to the furnace. From 12 to 20 per cent is required to operate the blowers. The remaining is available for the generation of power. This gas may be burned directly in gas engines, used under steam boilers or as fuel in metallurgical furnaces and byproduct coke oven plants. In general, sufficient power can be generated from the gas to supply all the power requirements of the mills and, in some cases, additional power for sale. Table II shows typical analyses of blast furnace gas.



Sketch of gas producer with reactions noted

TABLE II—ANALYSES OF TYPICAL BLAST FURNACE GASES

	Yearly Average, Six Furnaces in One Plant 1916	1918		Yearly Average, Six Furnaces in One Plant 1916	1918
CO_2	12.4	12.9	CH_4	0.0	0.0
O_2	0.0	0.0	N_2	58.1	57.1
CO	25.6	26.3	B.T.U.	93.1	94.8
H_2	3.9	3.7			

Data from "American Fuels," Bacon and Hamor.

Blue Water Gas

Blast-furnace and producer gas have a low heating value because 79 per cent of the air supplied to the fuel bed is inert nitrogen which results in a gas having a nitrogen content of over 50 per cent. To produce a gas of high heating value, some source of oxygen must be used which does not contain inert nitrogen. Steam is used for this purpose in the manufacture of blue water gas. If steam is blown through a bed of incandescent carbon which is at a temperature of more than 1,800 deg. F., the following reaction occurs:

$$C + H_2O = CO + H_2 \qquad (3)$$

This reaction is accompanied by the absorption of 5,967 B.t.u. per pound of carbon from the fuel bed and consequently produces rapid cooling. When the temperature

[1] Haslam and Russell—"Fuels and Their Combustion," McGraw-Hill Book Company, Inc.

[2] "American Fuels," Bacon and Hamor.

of the fuel bed falls below 1,000 deg. C. (1,832 deg. F.) reaction (3) is superseded by the following:

$$C + 2H_2O = 2H_2 + CO_2 \qquad (4)$$

This is accompanied by an absorption of 5,908 B.t.u. per lb. of carbon and sets in at about 1,000 deg. C. (1,832 deg. F.) It practically ceases at 625 deg. C. (1,157 deg. F.). Reaction (3) produces a gas having an analysis of 50 per cent CO and 50 per cent H_2, with a heating value of 324 B.t.u. per cubic foot at 60 deg. F. The gas produced by reaction (4) has an analysis of $66\frac{2}{3}$ per cent H_2 and $33\frac{1}{3}$ per cent CO_2, with a heating value of 217 B.t.u. per cubic foot. Both of these reactions bring about a rapid drop in fuel-bed temperature due to the absorption of heat caused by the decomposition of the steam. The quality of the gas decreases as the fuel bed is cooled, and the percentage of steam decomposed falls off also, so that it is necessary to stop the formation of blue water gas when the fuel bed has been cooled to about 800 deg. C. (1,472 deg. F.). The part of the cycle of operations during which steam is decomposed in the hot fuel bed to form blue water gas is called the "make" or "run" period.

The "run" period is followed by a "blow" period, during which air is supplied to the fuel bed. The carbon is burned to CO_2 and as the fuel-bed temperature rises, part of the CO_2 is reduced to CO. The gases produced during the blow are quite low in heating value and may be wasted to the atmosphere. As soon as the temperature has risen sufficiently, the air blast is shut off and the steam blast is turned on, thus starting the cycle again.

Table III shows a typical analysis of blue water gas. The gas consists mainly of hydrogen and carbon monoxide and has an average heating value of about 310

TABLE III—ANALYSES OF TYPICAL BLUE WATER GAS AND CARBURETED WATER GAS

	Blue Water Gas		Carbureted Water Gas	
	Sample A	Sample B	Sample A	Sample B
CO	43.5	39.1	33.4	28.1
H_2	47.3	49.3	38.1	21.8
CH_4	0.7	0.8	7.6	30.7
CO_2	3.5	6.8	3.3	3.8
O_2	0.6	0.3	0.7	0.5
N_2	4.4	3.7	3.8	2.2
C_2H_6	....	....	2.4	....
Illuminants	....	....	10.7	12.9
B.t.u. per cu. ft.	302	295	602	660

B.t.u. are the lower B.t.u. per cu.ft. at 60 deg. F.
From "American Fuels," Bacon and Hamor.

B.t.u. per cu.ft. at 60 deg. F. Although this is about one-third of the heating value of natural gas, blue water gas burns with a higher flame temperature than does natural gas, on account of the absence of inert gases. The flame is blue and non-luminous, from whence it derives its name. It can be used in all industrial applications requiring a high temperature, but its principal application is in the manufacture of carbureted water gas.

Bituminous Coal for Water Gas Manufacture

In the past, coke has been the common fuel used in the manufacture of water gas. Over a period of twenty years it has cost from $2.50 to $3 per ton more than bituminous coal. Consequently, many attempts have been made to substitute bituminous coal as water-gas-generator fuel. The most serious difficulty encountered has been a reduction in capacity, especially in the larger machines. Blow-holes formed at and near the walls, lessening fuel bed resistance and thereby increasing the air flow, rate of combustion and temperature in this section of the fuel bed, at the same time leaving a cold center. The introduction of 30 to 50 per cent coke or anthracite helped this situation. The use of special, screened bituminous gas coals has also been successful.

Another objection to the use of bituminous coals in water-gas sets has been the production of objectionable smoke immediately after charging. This has been overcome by using a blow run, followed by a steam run, immediately after charging, thereby running the volatile hydrocarbons into the gas holder.

Carbureted Water Gas

About 60 per cent of the artificial gas distributed in the United States for public consumption in 1923 was carbureted water gas. It is made by enriching blue water gas by an oil gas made by spraying oil on to a heated checkerwork of brick. The heating value of the resulting gas depends upon the amount of oil gas produced per cubic foot of blue gas. The blue gas has a heating value of about 300 B.t.u. per cu.ft. and the carbureted water gas ordinarily has a heating value of about 530 B.t.u. per cu.ft.

In the manufacture of blue water gas, the gases leaving the generator during the blow period are wasted unless arrangements are made to burn them under a boiler. In the carbureted water gas plant, these gases are conducted from the top of the generator to the top of the carburetor, where they are mixed with sufficient air to complete their combustion. They are burned in the carburetor and superheater and are utilized thereby to heat the brick checkerwork and maintain it at a temperature of about 1,400 deg. F. The burned gases are vented to the atmosphere through the stack at the discharge end of the superheater.

During the run period the blue water gas leaving the generator is conducted to the top of the carburetor, where it mixes in its downward passage through the carburetor, with an oil gas formed by spraying oil on to the hot brick checkerwork in the carburetor. The function of the carburetor is to crack the oil, vaporize it and produce an "oil" gas by heating the oil to a temperature of about 1,400 deg. F. in the absence of air. The mixture of blue gas and oil gas passes downward through the brick checkerwork in the carburetor and then upward through the hot checkerwork in the superheater and through the water seal on the discharge of the superheater, to the scrubbers. The function of the superheater is to maintain the oil gas at a high temperature and to "fix" the constituents of the gas so that they become "permanent" gases which will not condense and separate from the blue gas in the holders and mains.

The oil used in manufacturing carbureted water gas is a "gas oil," which is a light fuel oil, being heavier than kerosene and lighter than the lubricating oils. The fuel cost of the B.t.u. produced from the oil is three or four times the fuel cost of the B.t.u. produced from the fuel burned in the generator. As a result, only enough oil gas is added to raise the heating value of the resulting gas to the legal standards required. This is generally between 530 and 570 B.t.u. per cubic foot, but there is a growing tendency to decrease this standard. Table III also shows the analysis of typical carbureted water gas. The "illuminants" are hydro-carbon compounds obtained from the oil introduced into the carburetor.

Carbureted water gas is used almost exclusively as a city gas. It has the advantage over coal gas of requiring a smaller and cheaper plant, occupying less space and possessing more flexibility in operation.

In general, the fuels made by the complete gasification of coal are not used for the production of power, with the exception of blast furnace gas, which is a byproduct of a manufacturing process.

Two-Phase and Three-Phase Power

From the Same Transformers

By J. B. GIBBS

Transformer Engineer, Westinghouse Electric & Manufacturing Company

IN THESE days of rapidly developing power systems it is frequently desirable to be able to run two-phase motors from three-phase lines, or vice versa, or to be able to supply both types of motor from the same line. A number of methods have been proposed for accomplishing these results and several different transformer groupings are in use.

The connection shown in Fig. 1 has been suggested as a means of supplying two-phase and three-phase power simultaneously from a four-wire line, and it is interesting to compare it with other means for accomplishing the same result. Units *A* and *B* are a pair of three-phase to two-phase transformers connected in the usual way, and unit *C* is an auxiliary transformer which is used with the main transformer of the bank to give open-delta three-phase transformation. Two-phase power may be drawn from the lines *VX* and *YZ*, and three-phase power taken from the lines *XYZ*.

This connection may be represented diagrammatically as in Figs. 2 and 3. The simplified diagram, Fig. 3, shows that the secondary of the auxiliary transformer *C* ties to one end of the main transformer secondary *B* at *Y*, and to one end of the teaser secondary *A* at *X*, thus causing the voltages to assume relations the same as though the main and the teaser were connected together at the point *a* as in Fig. 2. Two-phase equipment can be operated from this circuit if the two windings of the device are not interconnected.

Now assume that a load is connected to the transformers. For simplicity of calculation say that the total load is 100 kva. and take the primary and secondary voltages as 100 volts between lines. If the total load is two-phase, transformer *C* will be idle, transformer *A* will carry full secondary current and transformer *B* will also carry the full secondary current for which it is designed. This current is

$$I_s = \frac{Kva. \times 1{,}000}{volts \times 2} = \frac{100{,}000}{100 \times 2} = 500 \text{ amperes.}$$

If the total load is three-phase, transformer *A* will be idle, and transformers *B* and *C* will carry the full current, which on the secondary is

$$I_s = \frac{100{,}000}{100 \times \sqrt{3}} = 577 \text{ amperes.}$$

At full 100-kva. output, therefore, the load on transformer *B* will be $\frac{577}{500} = 115.5$ per cent of its rating. If it is not to be overloaded, the three-phase load must be limited to $\frac{100 \times 500}{577} = 86.6$ kva.

If the total load is a combination of two-phase and three-phase, the amount that can be carried depends on the power factor of the two circuits. The worst condition will be when the power factors are such that the two-phase current in transformer *B* is in phase with the three-phase current. Under this condition Fig. 5 shows the relation of the two-phase and three-phase loads that can be carried without overloading transformer *B*. Thus, a three-phase load of 50 per cent of the bank rating may be carried at the same time as a two-phase load of 42 per cent of the rating, as shown in the figure by the dotted lines. Under this condition both transformers *A* and *C* will be underloaded and, therefore, will not be used economically.

As an alternative, consider the connection shown in Fig. 4. Taps are put in the secondaries of transformers *A* and *B* in the same way as in the primaries, and Fig. 3 applies also to this connection, except that in the simplified diagram transformer *C* is omitted and the secondaries of *A* and *B* are connected together at *a*.

If a two-phase load is carried on Fig. 4, the full-load

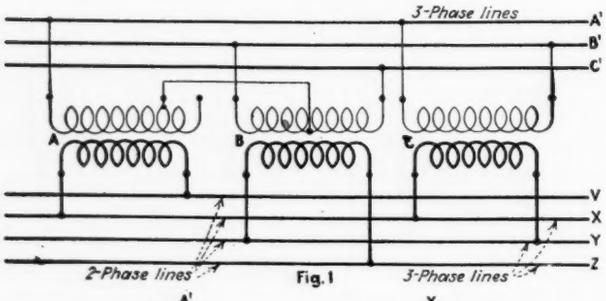
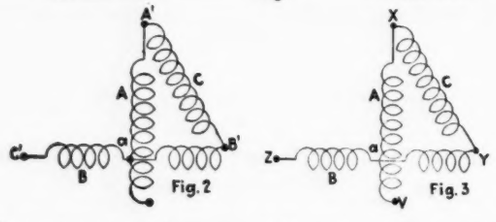


Fig. 1



Figs. 1 to 3—Diagrams of three transformers connected for supplying a two- and a three-phase load

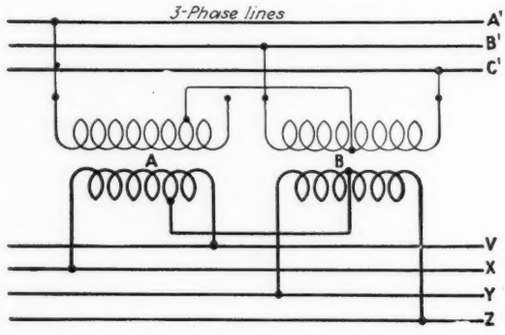


Fig. 4—Diagram of two transformers connected to supply a two- and a three-phase load

secondary current in A and B will be 500 amperes each, as before. If the load is three-phase, the secondary current in transformer A will be from a to X and the secondary current in transformer B will be 577 amperes from Z to Y. The maximum three-phase load that can be carried without exceeding the normal rating of the transformers is, therefore, the same as in Fig. 1; that is, 86.6 kva.

If the load consists of both two-phase and three-phase power simultaneously, the worst condition will be when

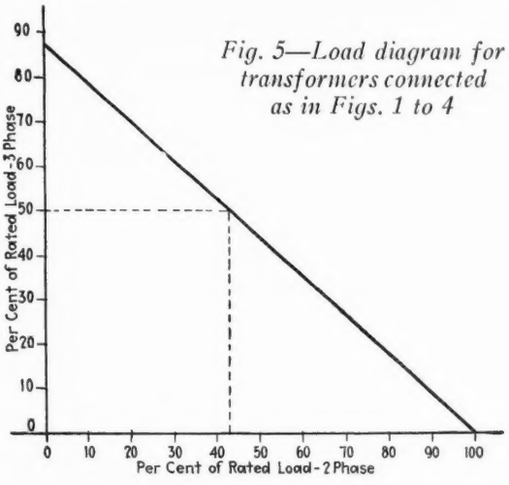


Fig. 5—Load diagram for transformers connected as in Figs. 1 to 4

the two-phase and the three-phase currents are in phase in either transformer. Fig. 5, therefore, applies to this connection also.

In summary, then, it may be said that the connection shown in Fig. 1 is practicable but not economical. If proper taps are added in the secondaries, the same results can be obtained from the two transformers in Fig. 4 as from the three transformers in Fig. 1.

Dynamic Braking, Regenerative Braking, or Plugging Control?

By E. F. Rogers

THE three terms, dynamic braking, regenerative braking and plugging control, are sometimes erroneously interchanged owing to a misunderstanding of just what they mean. Dynamic braking is obtained by causing a motor to act as a brake by connecting a resistance across its terminals to make it act as a generator. Dynamic braking is frequently used with direct current, such as series-wound motors operating the hoist motions of cranes. If a heavy load is suspended on the crane hook, it will overhaul the motor at a high rate of speed unless a dynamic braking resistor is connected across the motor terminals, and the motor acts as a generator forcing current through the resistor. It is the power required to generate this dynamic braking current that holds back the descending load on the crane hook and prevents it from coming down too fast.

If the dynamic braking resistance is low in value, it allows a heavy dynamic braking current to flow and the motor speed is low. If the resistance is high, then a small current flows and the crane hook lowers faster. In this way the crane operator can vary the rate of speed by cutting resistance in and out of circuit by means of his controller.

In the case of regenerative braking the motor does not circulate current through a resistor, but the motor remains connected to the supply lines and pumps current back into the power system. The power supplied to the line produces the braking torque to prevent overspeeding of the crane hook. This method is usually used with induction motors when a load is being lowered. When the operator turns the controller handle in the reverse direction, the motor quickly comes up to full speed. The load on the crane hook takes all load off the motor and tends to overspeed it. During acceleration the motor draws current from the line, but this current falls to zero at synchronous speed, and if the load is heavy enough to run the motor above synchronous speed, the current builds up again, but is now generated by the motor and fed into the supply lines.

If the motor is a slip-ring type, the speed is varied by the operator cutting resistance in and out of the secondary of the motor. There is, however, one very important difference here between dynamic braking with a direct-current motor and regenerative braking with an induction motor. With direct-current dynamic braking, it is possible to vary the speed over a wide range, from about 15 or 20 per cent of full-load speed to more than double speed. With alternating-current regenerative braking it is impossible to get any braking below full speed. All speed variation is obtained at speeds higher than synchronous speed. When all resistance is cut out of the induction motor secondary, it runs at slightly above synchronous speed. Cutting resistance into the motor's secondary does not cut down the speed, but, on the contrary, causes the motor to speed up with an over-hauling load.

Regenerative Braking

Regenerative braking in turn should not be confused with "plugging" the motor. To make a quick emergency stop, a motorman on a street car is occasionally seen to throw his controller handle from full speed forward to some point in the reverse direction. This procedure does not return power to the line as in the case of regenerative braking, neither does it retard the car by causing the motor to act as a generator and pump current through a resistor, but it takes power from the line. In other words, when "plugging" the motor, the motorman connects the motor for traveling in the opposite direction, and if he leaves the controller in the reverse position the car will start in the reverse direction after it has come to rest.

Plugging a motor should be done with discretion because the line voltage is superimposed on the counter-electromotive-force of the motor at the instant of plugging, and a large current flows, which decreases to a minimum when the motor gets up to speed in the reverse direction.

Owing to the fact that no speed control can be obtained with regenerative braking below the synchronous speed of the motor, it is quite usual to use regenerative braking with an induction motor for lowering a load and then plug the motor to rest. This is particularly efficient in some kinds of slope hoists where heavy loads must be lowered and some means of braking the load must be used.

Whether dynamic braking, regenerative braking or plugging control is used depends on the type of motor, the kind of load and other conditions of operation, and usually one of these methods of braking is better suited for a particular job than the others.

Right Out of the Plant

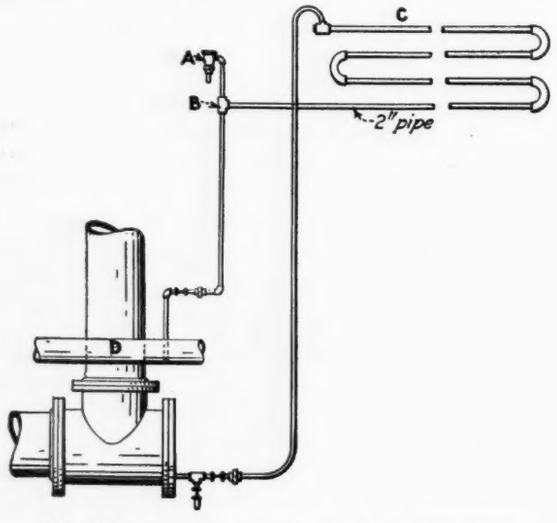
BOILED-DOWN EXPERIENCE PASSED ALONG TO THOSE WHO MUST SAVE MONEY, IMPROVE THE PRODUCT AND KEEP THE PLANT RUNNING

A Modified Steam Loop

IT IS surprising to find that so useful a device as the steam loop is not more generally used. The illustration shows a loop that is used to lift the condensation from low-pressure steam mains in tunnels and discharge it into return pipes at a higher level. These tunnels were built in low ground near the permanent water level. There was just about enough depth of earth to cover them.

The pitch of the main was two inches in about 750 ft. That of the branches was about the same. Loops were used to drain both the main and the branches. The condensers were made of 2-in. pipe and pitched return bends and hung upon the wall.

An air line valve *A* was connected to the upper end of a bull-headed tee *B* on the discharge end of the condenser *C* to remove the air and non-condensable gases. The lower end of the tee was connected to the return pipe *D*. For permanency a 1-in. brass nipple was screwed through the top of the return to within $\frac{1}{4}$ in. of the bottom of the pipe, thus water-sealing the nipple. Exhaust steam is used for other purposes than heating buildings, so the loops must work continuously. This they do whether the steam pressure is above atmospheric as in winter or



Modified loop used to lift condensation from lower to higher level

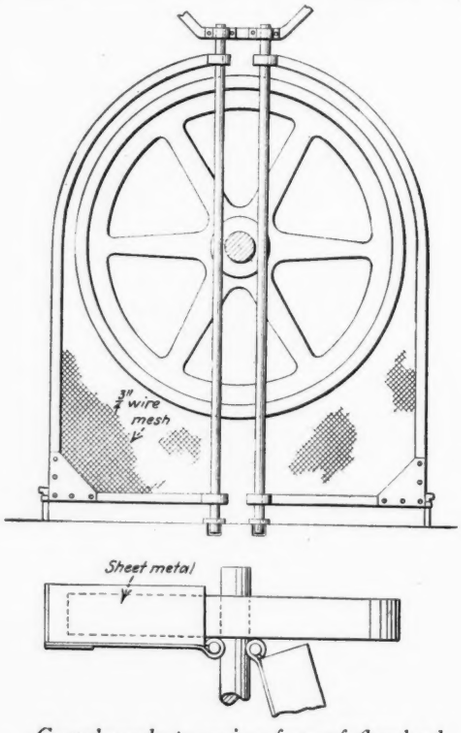
below it as in summer. They have operated many years without requiring attention. One of them stopped after seven or eight years of service. It was found that the pipes were partly filled with a scale-like substance. When this was removed, the loop worked as it did when first installed.

The steam loop has the advantage of reliable operation without much attention from the engineer. Certainly its operating costs is less than that of a steam pump and condensate receiver. W. L. PARKER.

Elgin, Ill.

A Practical Flywheel Guard

THE drawing shows a flywheel guard that can be swung back and so give access to the wheel for barring of center. It consists of two light angle-iron frames hung from center bars of ordinary iron pipe,



Guard made to swing free of flywheel

the latter being provided with pivoted and shouldered ends so as to hinge in metal sockets placed in the floor.

The sides of the frame are inclosed with light sheet iron, the front of the guard being covered with $\frac{3}{4}$-in. mesh wire netting. The top of the hinge tubes can be supported either from the roof or by means of stays from a convenient wall. Bolts, fixed on each half of the guard, drop into holes in the floor and keep the guard in position. The lower view shows one-half of the guard swung back free of the flywheel. W. MASON.

Liverpool, England.

Stopping Building Vibrations Due to Unbalanced Engines

SEVERAL years ago I had charge of the construction of a large power plant, which, when completed, swayed on its foundation so violently that provision had to be made to stop the motion to prevent serious damage to the building.

On account of the unsubstantial nature of the soil on which the plant was built, the plans provided that everything should be supported on piles. The engine bed was

intended to be independent of the rest of the building, and the piles that supported it were driven on 2½-ft. centers each way. These piles were cut off at about the level of the marsh, and a bed of concrete, extending down over the top of them about twelve inches, was installed to a height of about eight feet. On top of this bed of concrete the engine foundations were built of red brick laid up in portland cement to a height of about twelve feet.

The engines were cross-compound horizontal condensing units and were each of about 1,800 nominal horsepower and designed to run at 80 r.p.m. The flywheels were 24 ft. in diameter, built up in segments with boiler plates riveted on each, the complete wheel weighing over 125,000 lb. The 1,200-kw. generators were direct connected, the armature being built on the engine shaft.

When the first engine, which was on one end of the building, was started up and the speed brought up to around 72 r.p.m., the entire building began to rock back and forth. The engine was immediately slowed down, and even then the motion could be noticed to a slight extent. It was learned that the piles out by the coal trestle had moved perceptably and that the chimney foundation shook badly.

At first it was not thought that the vibration would cause any trouble, as slight vibrations have often occurred in constructions of this sort. About a week after this first experience, No. 1 engine, which had been run slowly

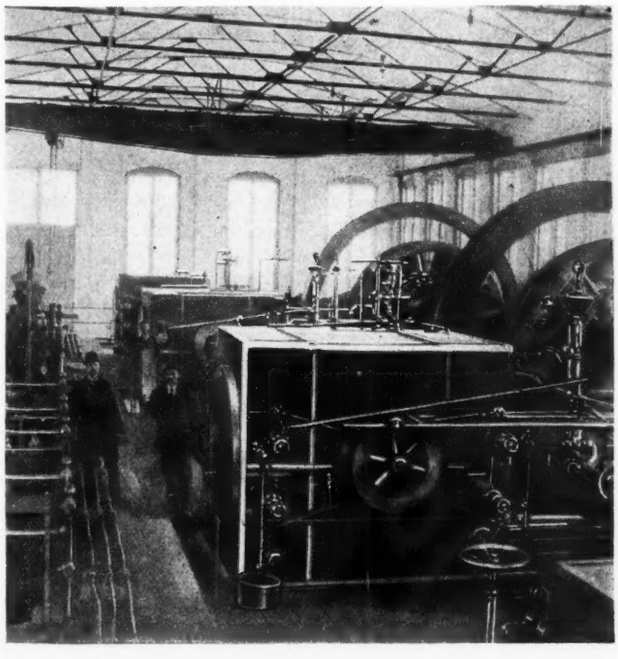


Fig. 1—Cross-compound engine on which the vibration was excessive, due to unbalance of reciprocating parts

for some time, was started on the line with load and ran for about five hours. The top of the chimney as seen in the transit was moving about one-fourth inch. The south corner of the building was moving about one-eighth inch, and on the north corner the building was moving about one-sixteenth inch in relation to the surrounding ground.

On the second day a crack showed up in the concrete floor. The next day the engine was slowed to around 68 r.p.m., which seemed to steady the building somewhat, although it would rock occasionally. The engine was run that way for about two weeks until No. 2 engine was ready to put on the line. When the two engines were tried together, the trouble became serious. The entire building swayed violently, the motion would come up to a maximum, die away gradually and then increase again at about two-minute intervals.

Cracks began to show in the walls of the building. A large crack showed up between the building and the

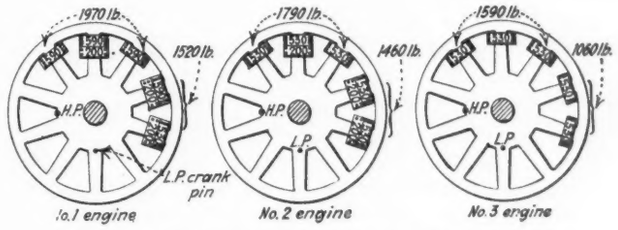


Fig. 2—Location of weights on engine flywheels

chimney, and the crack could be seen to increase and decrease. The building could be seen to move in relation to the brick pavement, etc.

Various suggestions were made by engineers as to how the vibration might be overcome, but after considerable thought had been given to the problem it was decided to counterbalance the reciprocating parts of the engine similar to a locomotive, and thus stop the trouble.

This was taken up with the engine builders, and while waiting to hear from them, three weights, each of about 200 lb., were made and bolted on the spokes of the flywheel about opposite the low-pressure crank or in line with the low-pressure counterweight that was cast in the crank disk. The low-pressure crank was located about 90 deg. after the high-pressure crank. These counterweights seemed to help slightly, but not enough.

Larger counterweights, part of them weighing about 590 lb. each and part about 530 lb., were made in two parts, so that they could be bolted around the spokes near the rim of the flywheel. As soon as these were received, they were installed on No. 1 engine, about 1,600 lb. being put opposite the low-pressure crank and about 1,200 lb. opposite the high-pressure crank. A telegram was received about this time from the engine company, to put 1,800 lb. opposite the low-pressure side and 1,500 lb. opposite the high-pressure side, but we put on the weights that we had. The weights reduced the movement very much.

The flywheel of the three engines were finally loaded as follows: No. 1, 1,970 lb. opposite low-pressure crank, 1,520 opposite high crank pressure; No. 2, 1,790 lb. opposite low-pressure crank, 1,460 opposite high crank pressure; No. 3, 1,590 lb. opposite low-pressure crank, 1,060 opposite high crank pressure.

The motion of the building with the three engines running was only about $\frac{1}{32}$ in. in about two-minute intervals, and even this was reduced after the entire marsh was filled up to the level of the basement floor and the filling became settled into place. These weights remained on the engines for several years.

Of course this is not a new method for stopping vibrations. Several years later the same method was used in another power plant, and a paper was presented before one of the scientific societies, going into the method in great detail. This also was successful and stopped the motion of the building.

CHARLES H. BIGELOW.

Plainfield, N. J.

As the Other Fellow Sees It

WHERE THE MAN WHO AGREES OR DISAGREES WITH AUTHORS OR EDITORS HAS A CHANCE TO SPEAK UP

Cutting in Boilers

THERE have been several articles in *Power* this year as to the proper method of cutting boilers into a line under pressure. This is an important matter, and I believe it is the cause of more accidents than is generally known. We had a serious explosion in this vicinity about a year ago, which was attributed to water hammer while cutting in boilers, though it was hard to prove it as both of the two men on the premises were killed.

The instructions given in the articles mentioned were good. However there is one point which I would like to call attention to. It is advisable that where two or more boilers are discharging into a common steam line, they should be fitted with what might be termed equalizing valves, that is to say, a line of two-inch pipe with a stop valve at each boiler. This line can be used as an auxiliary steam line to run pumps, etc., and steam will be on it at all times while boilers are in use. When cutting in a dead boiler, as soon as the steam gage reads within five pounds of the pressure on the line, open up the two-inch valve and this will greatly relieve the strain on the main valve when it is opened. This is especially true for large water-tube boilers. In fact when one remembers that it is not unusual for one steam gage to vary ten pounds from the others, it is surprising that the A.S.M.E. code does not recommend a small valve for this purpose, on each boiler. CHAS. P. WHITTY.

New Orleans, La.

* * * *

Beneficent Governmental Activity

THE admirable pamphlet on house insulation prepared for the Dominion Fuel Board, which is mentioned in your Foreword of August 7, no doubt will influence a good percentage of Canadian home owners. But would Americans accept as readily a similar pronouncement from their government? Are we so far advanced in our respect for government and governmental bureaus that we like to take their prescriptions?

Do our successful salesmen arm themselves with sheaves of Bureau of Standards' findings? Or do they take their prospects across the street to a disinterested private laboratory when a sale hinges on test data?

As early as 1912 the Bureau of Mines published a bulletin in which was stressed the fallacy of hollow wall construction as a method for reducing heat radiation from furnaces. In 1918 the Bureau of Standards gave us a report on the thermal conductivities of some forty materials, determined at approximately 25 deg. C.

The facts presented in these bulletins, however, have not interested very many of our prospects for heat insulation. Similar statements from the mouths of recognized power plant designers, on the other hand, have proved to be the most convincing sales ammunitions we can get.

Does our lack of respect for our governmental advisory and testing bureaus arise from the negligence of our technical editors in keeping us advised about their activities? Or is our instinctive aversion to anything that smacks of governmental dabbling a byproduct of the bureaus' own activities?

It would be interesting indeed to learn what the readers of *Power* think of the data that emanates from Washington. CHARLES MACCABE SMITH.

Celite Products Company,
Los Angeles, Calif.

* * * *

Ice Cake Weights and Dimensions

IN CONNECTION with the editorial in the July 3 issue regarding simplification of ice-cake sizes, some further explanation seems desirable in order to clarify the purposes of this action.

There has been much confusion due to excessive diversity in sizes of ice cakes of various nominal weights, because of variations in sizes of artificial ice cans and the practice of cutting ice for retail distribution from large blocks of varying weights and dimensions. This great diversity has not only caused complaint and misunderstanding among domestic consumers of ice, but has made it very difficult for refrigerator manufacturers to establish any sort of standard dimensions for ice compartments.

In July, 1927, a Simplified Practice Committee of the Refrigeration Industries was appointed at a preliminary conference of representative manufacturers, distributors and users of ice, refrigerators and refrigerating machinery. The Committee was authorized to undertake the establishment of standard dimensions for electric refrigerators wherever possible, particularly as to overall widths.

In gathering data for this purpose, the Committee found that the diversity in ice cake sizes made it impossible to reach any reasonable number of standards for refrigerators without first establishing standards for ice cakes. Accordingly, a careful survey was made in more than 100 communities in the United States to ascertain weights and dimensions of ice cuts in regular use.

After eliminating some few "freak" sizes and shapes of cuts, a tabulation was made to show prevailing practice in all important centers. Ice manufacturers and dealers, and refrigerator manufacturers were consulted personally and by correspondence. As a result of information and data thus secured, the Simplified Practice Committee formulated a recommendation that ice for domestic refrigeration be cut in the following weights: 25, 50, 75, 100 and 150 lb.

It being obviously impossible at this time to establish any single standard of dimensions for each weight, the Committee recommended that maximum dimensions for each weight, as actually existing in various communities, be stated in the recommendation, for the guidance of refrigerator manufacturers, and to prevent the growth of further diversity in size and shape.

Artificial ice is made in cans smaller at one end than at the other. Two standard cans are in general use, one

$11\frac{1}{2}$ in. x $22\frac{1}{2}$ in. at the top and $10\frac{1}{2}$ in. x $21\frac{1}{2}$ in. at the bottom, the other, 11 in. x 22 in. at the top and 10 in. x 21 in. at the bottom. A cut from the small end of a block must be higher than a cut from the large end in order to get the same weight.

The case of a 50-lb. ice cake is typical of all. Dimensions given in a table for this size are 12 in. x 12 in. x 16 in. A cake having all three of these dimensions would weigh over 70 lb. net, but, as stated in the Simplified Practice Recommendation, only one of these dimensions can ever be a maximum for a given cake. If it were 16 in. high, it would not exceed 10 in. x $10\frac{1}{2}$ in. in the other dimensions. On the other hand, if one of the latter dimensions were 12 in., the others would be about 10 in. and $14\frac{1}{2}$ in., respectively.

It has been difficult to make this matter wholly clear, on account of the natural tendency to assume that the three dimensions given represent the actual size of an ice cake, whereas their real purpose is only to show what any one dimension may be as a maximum. There has been general approval of the establishment of the five standard weights above mentioned, and an effort is now under way to establish exact dimensions for each weight as nearly as may be possible. All branches of the ice industries are collaborating in this effort.

Washington, D. C. R. M. HUDSON,
Bureau of Standards.

* * * *

Statistics and Power Plants

REFERRING to the editorial "Statistics and Power Plants," which appeared in the August 7 issue, I believe that every power-plant executive should have brought to his attention the aid that can be derived from the intelligent use of business statistics. The government has statistics available for many industries, and it is essential that general business conditions be carefully analyed, since most of the serious mistakes made in purchasing are due to a disregard of the business trend.

A shift in demand for finished products takes place at times, swelling or reducing volume of sales, not only of the products themselves, but of related lines, such as parts, accessories and semi-finished goods used in manufacturing the products. These shifts must be watched and provided against so far as possible. To be perceived clearly, they need to be studied in connection with comprehensive figures gathered for the particular industries at stated intervals and by reliable agencies. Herein lies the value of government data, the usefulness of which is sometimes called in question by short-sighted managers. Even though not so complete as often desired, these data enable the executive to take a long-time view of large movements in industry in general and his own industry in particular and to distinguish these from temporary and seasonal movements which from time to time produce fluctuations in demand. Not all of these changes are accounted for by exactly the same causes. Familiarity with these broader movements in industry, to be used as a guide to his own business, and to be taken into account in all his plans for the future, is almost as necessary to the executive as knowledge of rainfall, soils, and weather are to the farmer.

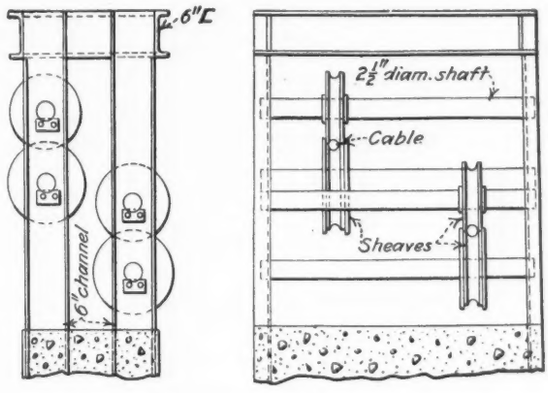
It is scarcely necessary to mention the innumerable collections of data which appear from time to time in the various trade periodicals. Such statistical service as that put out by the Harvard University Committee on Economic Research will, of course, be of much value.

On the whole, progressive executives and alert engineers can profit from intelligent use and application of current business statistics. HARRY KAUFMAN.
Philadelphia, Pa.

* * * *

Double Rollers Used As Cable Guards

AN ARTICLE in *Power* Aug. 7 explained the use of a wooden roller to keep hoisting cables from jumping off their sheaves. The accompanying sketch shows the manner in which we accomplish the same result in connection with two cables on a dragline.



Dragline cable guide

This dragline is used to move coal in and out of a 50,000-ton under-water coal-storage pit. It is remote controlled and there is considerable whip to the cables. There are two of these cable guides, one midway between the hoist and the head post, the other close to the hoist. The latter guide feeds the cables onto the drums evenly, eliminating the usual climbing of the cables on the drum.

Des Moines, Iowa. J. F. MCLAUGHLIN,
Des Moines Electric Light Company.

* * * *

Testing and Research

IN THE brief and able editorial "Testing is Not Research" which appeared in the July 31 issue, you touched on a growing practice whose roots enter even deeper into the mental make-up of the testing department than the mere sign over the door. Testing work should really be much more akin to production than it is to research. Research is original, seeks fundamental truths and is not scheduled as to time. Testing confirms assumptions, applies known facts and should be scheduled.

Too great a patterning after the research department often results in the inability of the busy, harassed production engineer or shop executive to get a prompt direct answer from the testing section, so that he eventually acquires the habit of foregoing the really useful information a test department should normally supply. When finally forthcoming, the testing department report is too often couched in the language of the laboratory, with its conclusions varying with contributing contingencies that are determinable only with highly specialized technical equipment and trained observers. Too often this trend away from the production idea results in reports which are not practical in their applications, and whose chief conclusion is that further test work should be authorized.

U. S. Navy Yard, JOHN F. HARDECKER.
Philadelphia, Pa.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

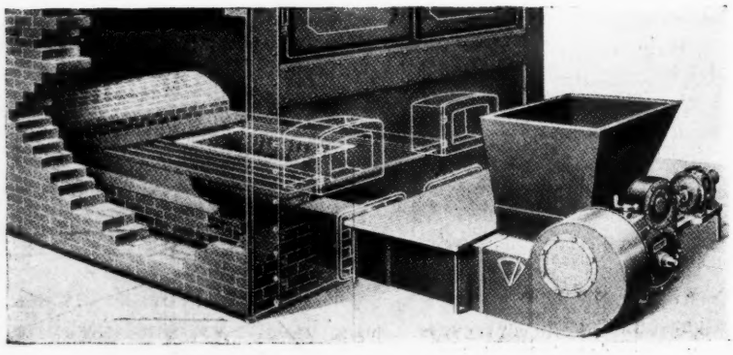


Fig. 1—Phantom view of stoker

Underfeed Stoker for Small Boilers

A TYPE of stoker designed for burning the cheaper grades of coal and adaptable to boilers between 250 and 2,000 sq.ft. of heating surface is being put out by Combustioneer, Inc., 1829-39 South 55th Ave., Chicago, Ill. A general view

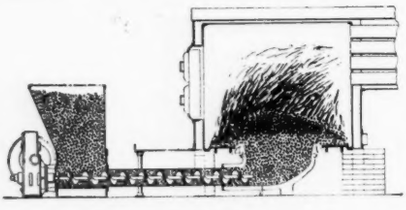


Fig. 2—Cross-section through retort

of the stoker is shown in the illustration, Fig. 1 and a cross-section of the retort in Fig. 2.

The stoker is self-contained in that the coal feed and forced-draft fan are interconnected and driven from a single motor. The coal is fed from a hopper to a retort within the furnace by means of a screw which forces the coal upward onto the grate. Air for combustion is admitted to the fuel bed through interchangeable sectional tuyeres at the top of the retort.

The speed reduction between the motor and screw is by means of a bronze worm gear and an all-steel overrunning ratchet clutch operated through a bronze connecting rod and oversized eccentric. The coal-feeding worm is semi-steel and is connected to the drive by a universal coupling protected against damage by safety shearing pins, the coal feed is adjustable while running, from neutral to maximum capacity. The stoker is equipped with an improved automatic control, and a forced-draft fan of the Sirocco type is used.

Ammonia Liquid Level Gage With Vacuum Jacket

A GAGE tube with a vacuum jacket which acts as an insulator to keep moisture from frosting the glass, is a feature of the "Lo-side" ammonia gage glass brought out by Meade Goodloe, 1830 West Slauson Ave., Los Angeles, Calif. The gage is designed for use on shell and tube brine coolers of either the submerged or insulated types as well as on accumulators.

The gage glass shown in Fig. 1 consists of two glass tubes *A* and *B*. The inner glass *B* serves to show the liquid level and outer tube *A* forms a vacuum jacket and insulates the glass. The spiral part of the tube at the top forms a spring and allows for expansion and contraction. The jacket tube is silvered to repel radiated heat.

The gage is fitted with a valve having a safety ball check at top and bottom and with the pipe *C* between the valves parallel with the glass. The lower valve forms a part of the baffle connection which traps the vapor bubbles formed in the valve and connection and conducts them upward through the pipe and so back to the vapor space in the evaporating unit. The length of the glass in sight is 15 in. and valves are 24¾ in. on center.

In Fig. 2 the gage is shown mounted on a liquid column *D* contained within the tank insulation. The function of this column is to permit separation of the gas generated in the lower connecting pipe without disturbing the liquid level in the glass. The gage is supplied ready to screw or weld to the shell or pipe connections.

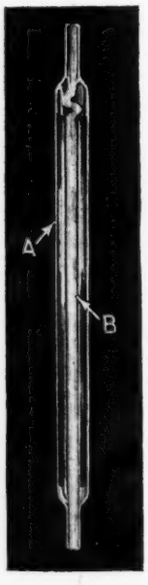


Fig. 1—Gage tube

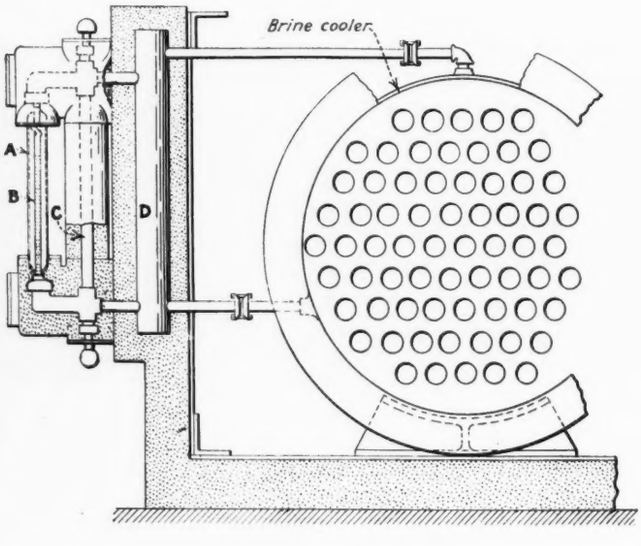
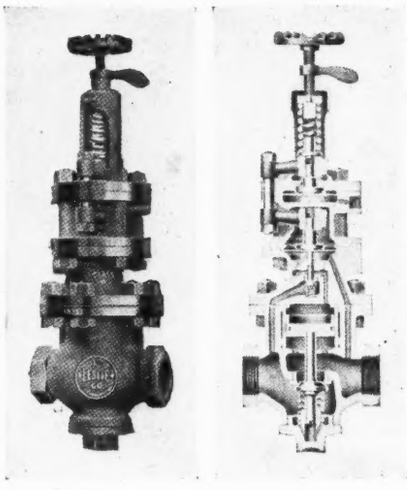


Fig. 2—Gage mounted on liquid column contained within the tank insulation

Improved Pump Regulator

CLOSE regulation and a wide pressure range in maintaining constant pump discharge pressures are some of the claims made for the improved pump regulator (illustrated) which the Leslie Company, Lyndhurst, N. J., has added to its line of pump pressure regulators. The regulator is adaptable for use with pumps handling water, oil or air, and is designed to maintain a constant pump discharge pressure at any desired point within the range of 25 to 200 pounds.

In operation the discharge pressure acts on the top diaphragm against the adjusting spring. Any movement of this diaphragm is transmitted through crossheads and connecting rods to a controlling valve, which admits high-



Assembly and cross-sectional views of regulator

pressure steam to the top of a piston, opening the main valve sufficiently to pass the required amount of steam to maintain the desired discharge pressure. The controlling valve is designed to be extremely sensitive and respond to the slightest change in pump discharge pressure. This insures quick action of the regulator and ample operating force under the widest and most sudden variations in load. The main valve is single-seated. The regulator is self-contained, has no stuffing boxes and is fitted with renewable wearing parts.

The device is made of high-grade bronze and is recommended for a working pressure of 250 lb. and total temperature of 580 deg. The sizes carried in stock range from ½- to 2-in. with both screwed and flanged ends.

Gas-Proof Heavy-Duty Portable Light

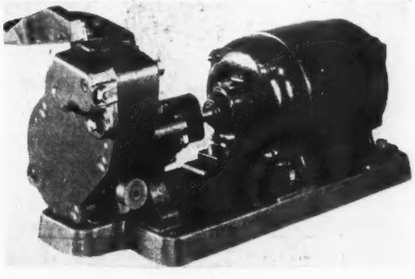
DEVELOPMENT of a portable light, which is water-tight, vapor- and gas-proof, has been announced by the Motor City Electric Company, 316 West Jefferson St., Detroit, Mich.

Assembly of lamp with extension cord

The base of the light is made of heavy brass, provided with a substantial hardwood handle. The lamp is protected by a glass globe that screws into the base, and is in turn protected by a heavy brass wire guard. The light is furnished with 25 ft. of rubber-covered cord, and an all-rubber plug.

Model A-10 Unishear

ANY line, whether straight, curved or irregular, can be followed through No. 10 gage sheet metal at a speed of about 10 ft. per min. with



Model A-10 Unishear cuts No. 10 gage plate

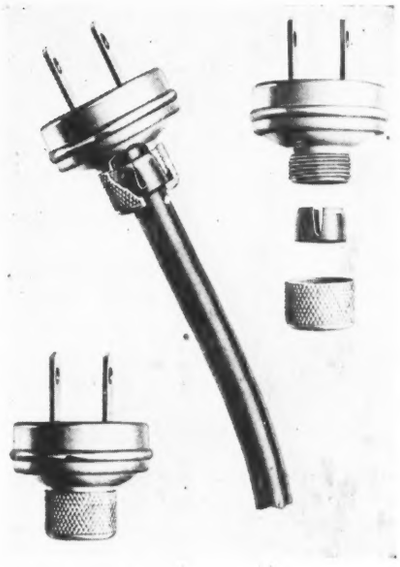
the new model A-10 Unishear, illustrated herewith.

The machine is similar in principle to other units developed by the Unishear Company, 270 Layfayette St., New York City. It will also handle notches and angles.

The model illustrated is driven by a ¾-hp. motor running at 3,450 r.p.m. Motors to suit any voltage or frequency can be furnished complete with proper starter. A sheet stabilizer to be used with the machine is also available.

Attachment-Plug Cap Grips the Cord

AN UNBREAKABLE attachment plug cap with an improved type of cord grip, shown in the figure, is announced by the Cutler-Hammer Manufacturing Company, Milwaukee, Wis. The grip acts as a positive strain relief and is designed particularly to lessen short-circuit hazards. Fastening the cord grip is a simple matter and can be done without the use of



Parts and assembly of cord-grip attachment plug

tools. It is only necessary to screw down on the knurled collar.

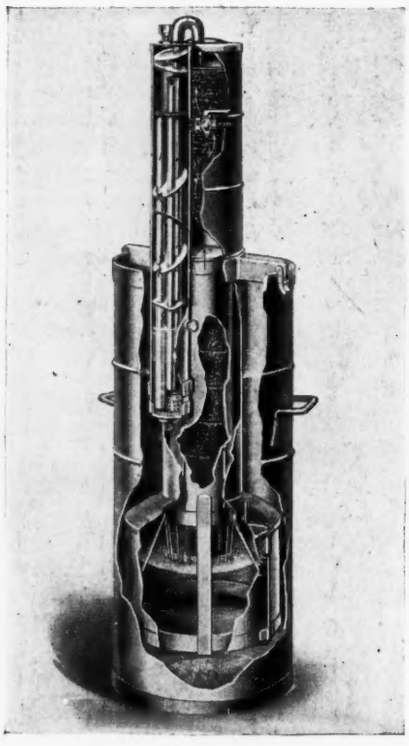
The knurled collar wedges a fiber bushing tightly against the cord. The parts are so designed that a pressure from the inside prevents loosening of the knurled collar and insures that a firm grip is maintained at all times.

A fiber grip bushing serves to insulate the cord from metal parts and results in less damage to the cord because it prevents contact between cord and metal. This bushing also acts as the clamp and is the only part that actually touches the cord.

The cap is identical with the unbreakable "Dreadnaught" line of caps made by the company. A rustproof armored shell, made of heavy brass, prevents breakage when dropped on cement floors, etc. Sheet bakelite is used to hold the blades firmly in place.

New Low-Pressure Acetylene Generator

THREE sizes of Carbic low-pressure acetylene generators are being put out by the Oxweld Acetylene Company, 30 E. 42nd St., New York. These are known as types B, K and X, which will generate 45, 80 and 30 cu.ft. of acetylene per hour,



Phantom view of generator showing tank, bell and holder

respectively, at a pressure of less than one pound. It is claimed that type B is of ample capacity for any cutting operation and any but the heaviest welding and heating jobs Type K will handle any job possible with one torch, and type X will weld metal up to $\frac{3}{8}$ in. in thickness and cut iron and steel up to approximately 2 in. in thickness.

Simple construction and operation are features of this generator. It consists of three parts—the water tank, gas bell and cake holder. The cakes of Carbic are shown in place. All seams and joints of the three parts are welded and the assembly is completely galvanized. After the cake holder is charged, the gas bell is lowered into the water. The water rises inside the bell until the displaced water is balanced by the air pressure built up. When the gas valve is opened, air escapes and the water rises into the gas bell until it contacts with the lowest Carbic cake. The gas generated then forces the water away from the cake. When acetylene is drawn off, the cycle is repeated, but equilibrium is restored before a dangerous pressure is built up. The residue drops to the bottom of the tank, accumulates there and raises the level of the water enough to compensate for the water used in the generation of gas. The charging of the generator with new cakes requires about three minutes.

The height and diameter of the types B, K and X are 54x14 in., 58x 26½ in. and 39x14 in., respectively. The weights, fully charged, are 210, 694 and 124 lb. The time that the gas is available for full charge at full capacity of generation is 2, 3, and 1⅓ hours respectively.

Phomene Accumulators for Fire Fighting

THE illustrations show the stationary and portable types of Phomene accumulators being put out by the Pyrene Manufacturing Company, 560 Belmont Ave., Newark,

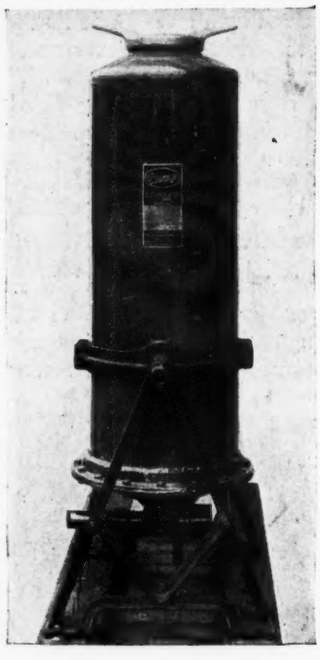


Fig. 1—Stationary model gives 2,400 gal. of foam from one charge of powder

N. J. This is a foam-making device designed to provide automatic fire protection. The operation of the outfit is as follows:

The accumulator normally contains a charge of a dry powder that produces a thick foam when mixed with water. When fire breaks out, the opening of one or more standard sprinkler heads located at the hazard allows water to be forced into the accumulator and the foam mixture is discharged. An automatic valve that has been especially designed for this service is used in connection with the accumulator and serves the double purpose of turning water on as soon as a fire starts and turning it off again as soon as the foam discharge has been completed. The object of the latter action is to prevent an excess of

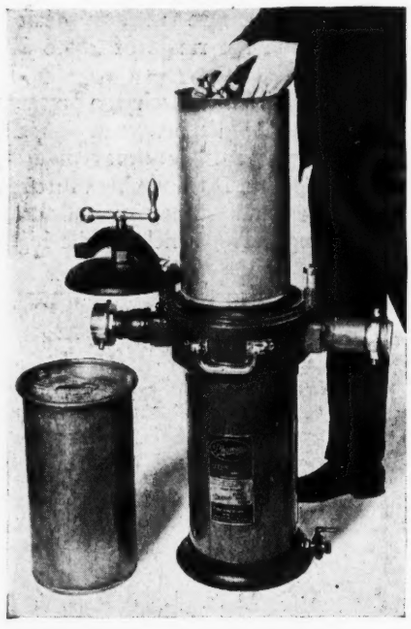


Fig. 2—How the portable model is charged with the foam-making powder

water overflowing the inflammable contents of tanks protected by this system.

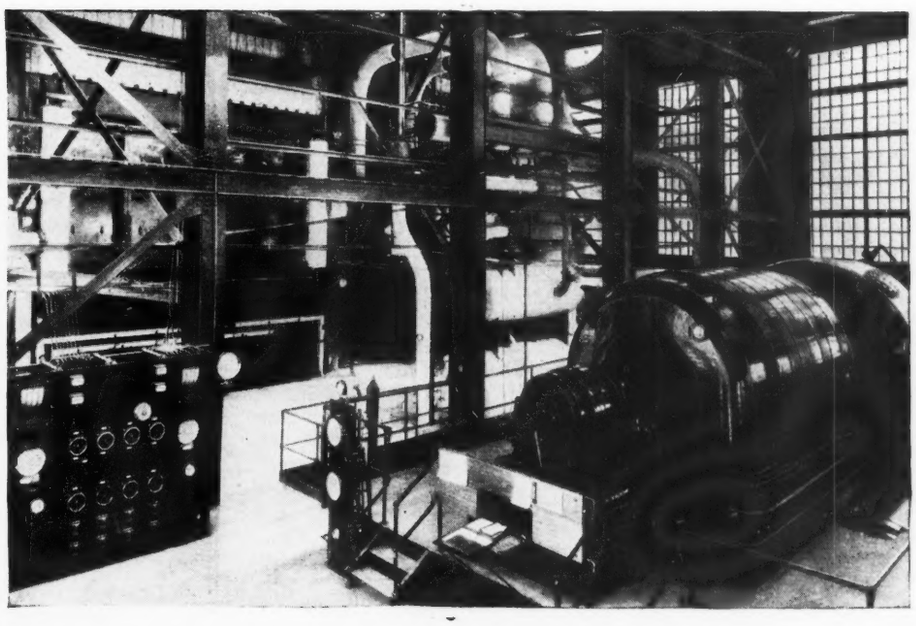
If desired, an electrical thermostat control may be used in place of sprinkler heads located at the hazard.

In the portable model No. 401, shown in Fig. 2, the head is designed to swing on a vertical hinge to one side to permit the insertion of the powder container, which is especially designed for this model, directly into the accumulator. Under a water pressure of 50 to 60 lb. per sq.in. the stationary model (Fig. 1) will, it is claimed, discharge 2,400 gal. of foam in about 2½ min.

The portable model shown in Fig. 2 is designed to give 280 gal. of foam and the discharge time is from 1½ to 1¾ min. This model requires a water pressure of 30 lb. or over for proper operation. If desired it can be supplied for automatic or semi-automatic operation and for portable use as illustrated.

Boiler and Turbine Rooms Merged in New
Avon Park Station

By R. D. Stauffer and J. P. Garvin
Engineering Department, W. S. Barstow & Company



No wall separates boiler room and turbine room. Control is centralized so that one man can supervise operation of entire plant.

THE necessity for additional generating capacity for the Florida Public Service Company's system in Central Florida became evident immediately after a disastrous fire at Lake Wales wiped out the company's largest standby station. In the design of the new station it was necessary to keep in mind that a simple steam-generating station was required which could be operated economically and with a minimum of labor, as the load on the system had not developed to the point where this new station would operate at a high load factor.

The Avon Park station is situated on a 47-acre tract of land adjacent to Lake Lotela, about 1½ miles from Avon Park. The station is owned by the Florida Public Service Company and is operated by W. S. Barstow & Company, Inc., who were also the designers and builders. The site is in the form of a peninsula and bounded almost on three sides by water. Condensing water is taken in from one side of the peninsula and discharged on the other side, making recirculation practically impossible.

The construction of the station was begun on April 1, 1927, and it was started upon a period of operation on Feb. 1, 1928. Avon Park station is designed for an ultimate capacity of 80,000 kw. At present one 15,000-kw. unit is installed.

Fuel oil is now used, but combination fuel oil and pulverized coal burners have been installed.

In the arrangement of the plant careful consideration was given to the ease with which the plant could be operated. All of the equipment possible was located at one floor elevation. Equipment which could not be placed on the operating floor was located in the basement and, as far as possible, in such a way that it could be observed from the operating floor.

There are no dividing walls between the boiler room and turbine room or between the turbine room and switch-bay. In this way almost everything in the plant can be seen by a single operator in walking around the turbine.

The turbine room is 37 ft. wide and the turbine is placed lengthwise in the room. On the west side of the turbine room is the 20-ft.-wide switchhouse, one story and basement. The space beneath this electrical bay in the basement is occupied by circulating water pumps, house service pumps and bleeder heater condensate pumps.

At the operating floor level only a platform on three sides of the turbine is provided, but at the end of the turbine toward the temporary end of the building an entire bay of the turbine room floor was provided. Here are located the main switchboard adjacent to the electrical bay, the boiler control switchboard adjacent to the boiler room and the operator's office and telephone booth. This arrangement makes the main switchboard and the boiler control switchboard visible from a single position.

Absence of a wall between turbine and boiler rooms and centralization of control equipment permit one-man operation in the Avon Park Station. This abstract is based on an article appearing in the August 25 issue of *Electrical World*

On the east side of the turbine room there is a 23-ft.-wide bay forming an aisle in front of the boilers. This is actually a part of the boiler room. The boilers are arranged so that their fronts face the turbine room, and the fact that there is no dividing wall between the boiler room and turbine room simplifies the operation of the boilers materially.

Behind the boilers on the operating floor are the induced draft fans, two per boiler. In front at the operating floor level, in the aisle between boilers, the deaërating feed water heater is located so that it is immediatly before the operator at all times.

The boiler feed pumps and forced-draft fans are located in the basement in such a manner that they are visible from the turbine operating platform.

There are eight Peabody combined fuel oil and pulverized coal burners installed for each boiler at the present time, but places are provided for four additional burners per boiler. As the Peabody wide-range system of firing is used, oil from the burners is returned to the storage tank. It is first carried

over, however, to the boiler control panel, where the pressure on the return line is controlled by a pilot valve, which varies the return oil pressure and consequently determines the amount of oil burned and the boiler rating.

The furnaces are entirely refractory for the present, with the exception of the radiant superheaters, although provision is made for the future installation of water-cooled furnace walls. The furnace is 21 ft. 9 in. wide inside by 17 ft. deep and has a furnace volume of 10,200 cu.ft.

Side walls and bridge wall are of the Detrick side wall arch construction and are air cooled. The furnace bottom is also air cooled. Observation doors are provided at various points for proper observation of the furnace conditions. A Detrick arch is provided at the top of the furnace and the boiler tops covered by two courses of fire brick and 85 per cent Magnesia insulation.

There are two Sturtevant forced-draft fans to each boiler, all driven by variable-speed motors. Draft dampers are remotely controlled and together with other boiler controls are grouped on the boiler control panels according to boilers.

The electrical apparatus for boiler controls are grouped on two central boards, while the system-indicating instruments and fuel-controlling apparatus are mounted on two end boards, thus eliminating the possibility of drips of steam instruments coming in contact with electrical instruments and wiring.

All unnecessarily complicated control apparatus was omitted in the layout of this station. Simplicity, together with centralized control, all located on one floor level, were considered paramount to meet the operating conditions demanded by the present system requirements.

There are two 13,100-ft. Casey Hedges bent-tube, five-drum boilers installed for the present first unit. These boilers are built for a working pressure of 448 lb. per square inch and are operated at 428 lb. per square inch.

Foster-Wheeler combination convection and radiant superheaters are installed, the convection superheater being located behind the front bank of boiler tubes, while the radiant superheater is located in the front wall of the boiler above the burners.

Each of the boilers is equipped with a separate Foster economizer having 7,776 sq.ft. of heating surface.

The induced-draft fans and motor-operated air-cooled dampers are remotely controlled from the boiler control panel.

The main turbo-generator is an Allis-Chalmers 15,000-kw., 80 per cent power factor, 13,800-volt, three-phase, 60-cycle, 1,800-r.p.m. unit with a direct connected 250-volt exciter. The turbine is designed to receive steam at 400 lb. per square inch gage pressure, 715 deg. total temperature and to exhaust at 28¼-in. vacuum. Openings are provided at three points to permit extraction for heating of feed water.

The main turbine exhausts into an Elliott single-pass, two-compartment condenser having 16,500 sq.ft. of tube surface and capable of condensing 160,000 lb. of steam per hour to 1.75 in. of mercury absolute pressure when using 22,000 gal. per minute circulating water at 70 deg. F. temperature. The water boxes are divided vertically, with a circulating water inlet and outlet connection into each compartment so as to be able to clean or maintain one side of the condenser with the other side still in service.

The circulating water is supplied by two 11,400-gal.-per-minute centrifugal pumps, one motor driven and the other with dual drive.

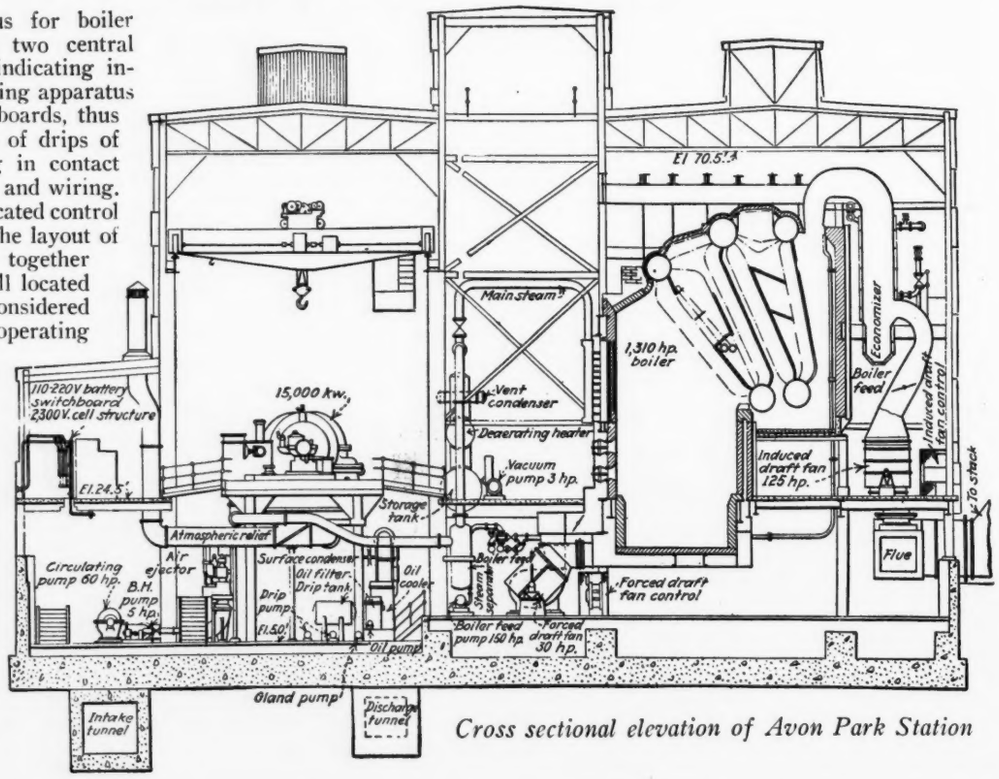
Cochrane feed water heaters are used, the first extraction heater being of the tubular type, four-pass design, having 785 sq.ft. of surface and the other of the same design, having 540 sq.ft. of surface. The Cochrane deaërating heater has a capacity of 250,000 lb. per hour and performs the very necessary function of eliminating the oxygen from the feed water. With higher pressures and temperatures and pure distilled feed water oxygen corrosion is a serious factor and must be eliminated.

The main control boards for generator, exciter, main station service circuits and outgoing feeders, together with boiler control boards, are situated in the central bay 20 ft. from the boiler control board. The turbine gage board stands at right angles to these boards and at the end of the unit in proximity to the boiler control board. This arrangement of boards puts the essential controlling apparatus within easy reach of the single plant operator in time of trouble.

Usual operation requires the operator to remain at the boiler control boards, and as firing rate and water rate depend on load, the wattmeter, frequency meter and governor control button are duplicated on this board, thus minimizing the steps the operator must take during times of load fluctuation.

The generator has an inclosed air-circulating system cooled by means of a Griscom Russell surface type generator air cooler, having 13,250 sq.ft. of surface.

All controls on the main switchboard are as simple and compact as possible. Single plug synchronizing is used and all circuits are synchronized back to the tow-tension side of the transformer bank. In case of internal fault in the generator it is automatically removed from the line, leaving the operator free to readjust boiler operation and leaving the transmission system intact electrically as far as interchange of energy between the 33-kv. and 66-kv. systems is concerned.



Cross sectional elevation of Avon Park Station

Avon Park Station

Present capacity, 15,000 kw. Ultimate capacity, 80,000 kw. Throttle steam conditions, 400 lb. and 715 deg. F. Economizers and deaerating heaters used. Control of boiler room and turbine room operation from a single location commanding a view of the principal units.

Fuels, Power Generation, Application And Research Discussed at

Twin City A.S.M.E. Meeting

WITH a splendid technical program, numerous inspection trips and varied entertainment, the summer meeting sponsored by the St. Paul and Minneapolis sections of the American Society of Mechanical Engineers proved to be a most profitable and enjoyable affair. An added inducement to attend for members from the eastern section of the country was the Great Lakes' tour starting from and returning to Buffalo, with stop-overs en route at the Soo Locks, at Houghton, the metropolis of the Lake Superior copper country, at Duluth with a visit to the Mesaba Iron Range and finally at Winnipeg as guests of the Engineering Institute of Canada. A party of 96 took advantage of this opportunity to see the famous mining regions of the country and, with delegations from various points of the Northwest, helped swell the attendance to a figure approximating 300. Throughout the meeting, lasting from Aug. 27 to 30, headquarters were at the St. Paul Hotel.

Preceded by a council meeting with President Dow officiating, the technical program began on Monday afternoon and was continued mornings of the succeeding days of the meeting. To cover the varied engineering interests of the Northwest, ten different sessions with a total of twenty-three papers had been arranged. The general subjects were steam and hydraulic power, fuels and materials handling, aeronautics, applied mechanics, apprenticeship training and research, with other sessions devoted to certain power problems in iron mining, the printing industries, paper mills, flour milling and agriculture, the last named being a joint session with the American Society of Agricultural Engineers.

Free afternoons of the meeting were occupied by inspection trips to the University of Minnesota, High Bridge steam power station and the leading industrial plants of the two cities. An alternate was golf for those preferring this form of entertainment. The leading social event was a banquet and dance on Wednesday evening featured by noteworthy addresses: one by Thomas D. Campbell, member of the A. S. M. E. and president of the Campbell Farming Corporation, at Hardin, Mont., who applies engineering methods to the operation of a 100,000-acre farm, and the other by Ralph Budd, president of the Great Northern Railway.

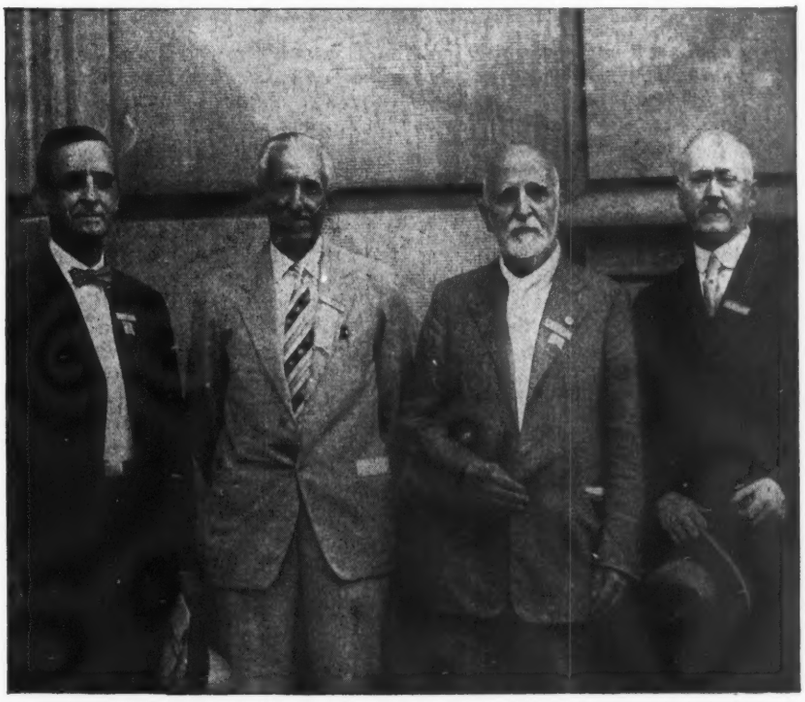
In addition to the foregoing events the entertainment program included an informal reception featuring research in aerodynamics by high-speed pictures, a dinner dance at the Woodhill Country Club, Lake Minnetonka, a luncheon by the Association of Commerce at the St. Paul Athletic Club, at which President Dow outlined the work of the society, and numerous events for the ladies.

Quite a number of the papers were of direct interest to *Power* readers. The session on aeronautics, with papers on "What's Coming in Aviation," by W. B. Stout and "Modern Airports and Airport Planning," by B. Russell Shaw, attracted the largest attendance. Another paper creating much interest and inducing prolonged discussion, favorable on the whole but seeking additional information, was presented by A. B. Kinzel on "Evaluation of the Technical Worth of a Steel from Physical Test Data." The author showed how the various properties of steel may be used to help determine the most logical factor of safety, based on the quantitative evaluation of the ability of the material to withstand service stresses.

Under the general topic of Fuels and Material Handling, Max Toltz pointed out the inherent advantages in various processes developed for the low-temperature distillation of low-grade fuels reviewing briefly what Europe has accomplished and pointing out in particular the problems that exist in applying this method of treatment to the lignites of the Northwest.

Drawing from European experience, particularly in Germany, the author inferred that the success of low-temperature distillation lies along the line of briquetting the char, thus facilitating its handling and shipping to the tributary country lying within the radius of low cost of transportation where it is possible to compete with other fuels. It would be available as a smokeless fuel for domestic, industrial and even railway use, and if the distance were not too great, the char could be shipped and after pulverization be used as fuel in the boiler plant.

In the power session, James A. Colvin commented upon the operating problems of the combined steam and hydro system of the Northern States Power Com-



Prominent officials at the meeting. Left to right: W. E. Brooke, head of department of mathematics and mechanics, University of Minnesota, chairman of the session on applied mechanics; S. C. Shipley, professor of machine construction, University of Minnesota, chairman of the apprenticeship session; Alex Dow, president of the society; J. P. Alford, editor of Manufacturing Industries, who presided at the session on aeronautics

pany extending in Minnesota and Wisconsin 250 miles east and west and 150 miles north and south, with approximately 75 per cent of the load concentrated in the relatively small area of Minneapolis and St. Paul.

The system has two major steam plants having a total capacity of 152,000 kw. and 85,400 kw. hydro capacity. Its development and growth were traced and some idea given of the problem of maintaining satisfactory voltage throughout the system in the face of extreme variations in power flow, and the characteristics of steam-plant operation, such as wide ranges of loading, seasonal variations of loading and low-load operation.

Local executive committee for A.S.M.E. summer meeting at St. Paul and Minneapolis. Left to right—Top row: E. W. Scofield, P. J. Frawley, C. A. Herrick, Paul Doty. Lower row: R. K. Culbertson, Lawrence Washington, J. J. Summersby, J. A. Colvin

Typical daily charts for different seasons of the year showed that in spring the water power carried the bulk of the load, and the steam plants the peaks. During the fall and winter, the reverse applied, the steam plants carrying the base load and water power caring for the peak conditions. This method of operation insured getting the maximum out of the water power plants, as they were operated to maximum capacity in the spring and in the dry months advantage was had of the full capacity of the streams by ponding.

Discussion turned to frequency control on a combined system, the impossibility of full automatic control, excess capacity and its effect in minimizing maintenance costs, and in steam operation, banking problems and the means for providing sudden excess capacity.

Edward H. Schofield analyzed costs of variable load and multiple power supply using as a basis three years' operation of the local street railway power system having a capacity of 50,000 kw. in steam plant and a variable capacity in water power ranging from 1,000 to 16,000 kw. The study includes a classification of costs designed to facilitate calculations of the effect of variable load, etc. By his method it is possible also to analyze and compare the results of changes in equipment and methods of operating or of the price and quality of fuel.

Harrison G. Roby, assistant hydraulic engineer of the Byllesby Engineering and Management Corporation, outlined the conditions that had to be met in the design of the 80,000-kw. hydro plant at the Falls of the Ohio near Louisville, traced the construction and showed methods and conditions by moving pictures. He summarized the features of the mechanical equipment, the operating conditions and the control.

It is believed that this is the largest station in which the units can be started or shut down from a supervisory board and which automatically goes out of service whenever trouble develops. Full details of the plant appeared in *Power* of Feb. 7, 1928.

Discussing the increasing use of power in iron mining in the Lake Superior District, A. C. Butterworth cited a group of twelve representative underground mines, nine completely electrified and the others partially electrified. In 1922 these mines showed a power consumption slightly less than 4 kw.-hr. per ton. A similar group of sixteen mines in 1927 showed a power consumption of slightly over 8 kw.-hr. per ton. Coincident with this increase in power consumption, the mining efficiency, as expressed in tons per man, nearly doubled in the same length of time.

The author anticipated a continued growth in the use of electric power in underground mines up to 12 kw.-hr. per ton of production. Comments on the uses of the power were of interest. For the year 1927 the pumping power for the previously mentioned group of electrically equipped mines amounted to 40 per cent of the total power consumption, or in other words, for every ton of ore produced, 2½ tons of water were pumped a vertical distance of 1,000 ft. The sum of the hoisting and pumping power amounted to approximately 50 per cent and the next largest single item, that of power used in compressing air, approximated 35 per cent of the total power.

In an interesting paper tracing the development in the use of steam and water power in the flour mills at Minneapolis, Maurice Dwight Bell, assistant superintendent of the Washburn Crosby Company, gave as the range in capacity per day, in one unit, 500 to 15,000 bbl., the most economical unit being about 4,500 bbl., owing to economy in labor and supervision and the lower cost and less chance of shutdowns, when compared with the larger mills.

In the older mills, production ranged from 2½ to 3 bbl. per day per horsepower. The coming of electric power influenced these figures to the extent that the power consumption now ranges from 7½ to 6 kw.-hr. per barrel. Taking the average cost for power in Minneapolis at ½c. per kw.-hr., gives a power cost per barrel of flour of 3¾ to 3c., this being about one-half the normal cost in other typical cities of the country except Buffalo.

Roughly the mill load may be divided as 15 per cent for wheat cleaning, 70 per cent for grinding on hard northern wheat, and 15 per cent for sifters, purifiers, elevators and packing. The torque required to start the mill with rolls apart is from 200 to 300 per cent of the full load torque. The daily operating load factor ranges from 85 to 95 per cent, with a yearly load factor, based on 720 hours per month, as high as 70 per cent. In the larger plants the power factor is 80 per cent or over.

Under the general topic of research, Prof. F. B. Rowley told of the research work that is being conducted at the University of Minnesota on the thermal properties of insulating materials and built-up wall sections of the types of construction used for houses in cold climates and for cold storage work. The author described the following two types of test apparatus used in this work: The hot plate which is best adapted for determining the thermal conductivity of homogeneous materials, and the hot box, best adapted for determining the coefficient of transmission through a built-up wall section.

Test results were given to show the effect of moisture and temperature on the thermal conductivity of the materials. The numerical value of surface constants was considered and a number of typical wall sections presented, showing in detail the construction and the insulating value by the hot-box method.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Canada Holds Another Successful Steel and Power Show

WITH upwards of one hundred exhibitors, the second Steel and Power Show, held at the University of Toronto Arena, Toronto, September 4 to 7, was fairly representative of the various lines of power and industrial plant equipment manufactured in the Dominion. A number of steel exhibits added much to the Show, the various kinds of steel and products made from them being attractively displayed.

A considerable number of American and British manufacturers were represented through their Canadian agents, with most of the equipment bearing their name, manufactured in Canada.

The Show was held concurrently with the Canadian National Exhibition at Toronto, giving the engineers from distant points an opportunity to attend both, with the important equipment in which they are interested assembled in one building from which the general public was excluded.

Technical sessions were held during the Show at which a number of papers dealing with the problems of power production and distribution were presented. Included among these were papers on "Special Valves and Their Application," by H. H. Shugart, A. W. Cash Company; "Economies of Central Heating," by M. Barry Watson, Consulting Engineer, Toronto; "Where Do We Stand on Welding and Why the Apathy," by R. E. Smythies, Vice-President, Lincoln Electric Company of Canada; "Special Refractories and Their Application," by J. L. Cummings, S. Obermayer Company; "Low Tension Light and Power Distribution Centers in Industrial Plants," by H. J. L. Frank, President Bulldog Electric Products, Detroit; "Principles Involved in Boiler Tests," by Chas. M. McKergon, Professor Mechanical Engineering, McGill University, Montreal, and a paper on Diesel engines by E. A. Allcut, Associate Professor of Mechanical Engineering, University of Toronto.

Radio Tubes Control Operation of Elevators

A new system of elevator control, by means of which elevator cars are automatically brought to the correct floor level, is announced by the General Electric Company. This method involves the use of a three-element vacuum tube similar to those used in radio sets. The vacuum tube is known as a pliotron and has been used for a number of years on railroad locomotives for the purpose of transmitting block signals into the engineer's cab in visible form so that the engineer does not have to depend on watching the semaphore and light on the side of the track. While it is similar to the common radio vacuum tube, it differs in the value of operating voltages which are used.

The use of the pliotron in the automatic leveling of elevator cars is based on the increase of plate current when the tube changes from an oscillating to a non-oscillating condition. A suitable number of tubes are mounted on each elevator car and these tubes are normally in oscillation. When the operator centers the car switch, by an arrangement of coils and vanes the motion of the car as it approaches a floor level is made to stop the oscillation of the tubes, thus actuating relays. The relays govern control circuits which slow up the car and stop it at the correct position.

Another application of the pliotron tube to elevator operation makes it unnecessary for the operator to watch his position in the hatchway. Devices similar to those used in automatic leveling are employed, and in addition a signaling equipment consisting of suitable push buttons, lights and a bell is used.

When passengers enter the car they call out the floor numbers at which they wish to get off, and the operator immediately presses push buttons corresponding to these floors. When all passengers are in the car, the operator starts by the usual method. As he approaches the first floor at which a stop is to be made, a signal light flashes and a bell rings, notifying the operator that a stop is to be made. He then throws the car switch to the off position and the car continues at full speed to a predetermined point in the hatchway where it is slowed up automatically and brought level with the next floor by the automatic leveling devices.

In addition to this arrangement, push buttons are installed on each floor. A passenger waiting for a car presses a button which lights a signal and rings a bell in the first car approaching in the direction in which the passenger desires to travel. A corridor lantern also lights to show the passenger which car will be the first to reach his floor traveling in the desired direction. An operator, receiving a signal from a floor push button, throws his car switch to the off position and the car is stopped in the same manner as described.

New Company Will Control Over One-Million Horsepower of Hydro-Electric Plants

International Paper and Power Company, the new company which is to be formed as a holding company for the properties of International Paper Company, and which is expected to hold a very large majority of the common stock of New England Power Association, will have developed and under construction in the combined companies, hydro-electric developments of 1,032,600 hp., and hydraulic power plants of 110,000 hp., making a total of 1,142,600. This total is capable of being increased through further development and through the utilization of undeveloped sites to a grand total of 2,600,000 horsepower.

Of this power, International Paper Company has 803,100 hp. developed and under construction in hydro-electric plants in the United States, Canada and Newfoundland, and 110,000 hp. in hydraulic power plants in its pulp and paper mills. The New England Power Association has 229,500 hp. developed and under construction in hydro-electric plants in New England on the Connecticut, Deerfield, and other rivers.

In addition, New England Power Association has 382,000 installed electric horsepower of central station steam plants. This amount added to the waterpower resources indicated above gives a present total capacity of 1,500,000 hp. and a prospective capacity of 3,000,000 horsepower.

World's Largest Electric Lamp

The world's largest electric lamp, a 50,000-watt experimental bulb built recently, is like a radio tube in appearance. At the top of the bulb, a radiator made of metal fins carries off the heat generated by the white-hot tungsten filament, which has a temperature of 5,500 deg. F., twice as hot as molten steel. The bulb is filled with nitrogen gas, whose circulation cools it and carries upward into the radiator tungsten particles thrown off from the filament, thus preventing blackening of the bulb. Although the present lamp is intended simply for test purposes such lights may ultimately find use in airport lighting and for the illumination of motion-picture studios.

Sloan Now Heads Three New York Utilities

Mathew S. Sloan was elected September 4 president and director of the United Electric Light and Power Company. Nicholas S. Brady, chairman of the board, resigned from the presidency to permit Mr. Sloan to become the executive officer.

With this election and his election announced last week, to the presidency of the New York Edison Company, Mr. Sloan becomes the operating executive of New York's three largest generating companies. It is expected that the directors of the New York and Queens Electric Light and Power Company will elect him president of that corporation.

It was also announced that George G. Cortelyou, president of the consolidated Gas Company, and John S. Garver of Shearman & Sterling were elected directors of the Brooklyn Edison Company thus completing the merger between the Consolidated Gas and the Brooklyn Edison Companies.

Seventh New York Power Show

One of the annual events of Industry and Engineering Practice which is awaited by manufacturers of industrial equipment and kindred products is the National Exposition of Power & Mechanical Engineering at the Grand Central Palace, New York, December 3-8, 1928. It provides industry and engineers an opportunity for comparison of similar products and is the means of increasing old business and adding new customers.

Already many exhibitors are represented in different sections under the various classifications.

At the present writing two hundred and seventy-seven exhibitors have obtained space in which to show power equipment such as boilers, stokers, fire brick, pipe, valves, pumps, etc.; one hundred manufacturers will show heating and ventilating equipment and ninety exhibitors will show transmission equipment such as belting, pulleys, drives, clutches, couplings, gears and speed reducers.

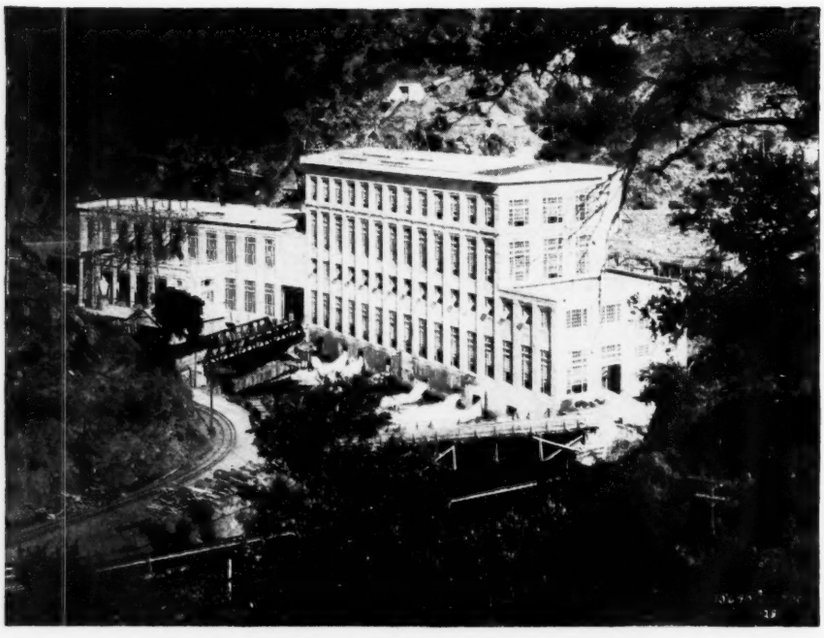
Novel Type Generators Sold To Carolina Power Company

The contract for the generators to be installed in the Saluda River hydroelectric development of the Lexington Water Power Company of South Carolina was recently awarded to the Westinghouse Electric and Manufacturing Company. The power plant will have an initial installation of 200,000 hp. and an ultimate capacity of at least 300,000 hp. Four waterwheels will first be installed, each of 50,000-hp. capacity. They will be connected directly to generators, each of which will have a rating of 40,625 kva. at 13,800 volts, and a speed of 138 r.p.m.

Radically new design features will be found in these generators, such as the elimination of upper guide bearings and the construction of the rotor in the form of an umbrella. The thrust bearing is to be mounted in the lower bracket under the rotor instead of at the top, as is customary.

One of the largest earth dams in the world will be built by the Lexington Power Company as a part of the Saluda River development. Lake Murray, which will be formed by the dam, will be 33 miles long and have an average width of 3 miles. At its widest point it will be 14 miles across. The site has already been cleared, and 1,400 men are at work building the dam. The dam is to be one and one-quarter miles long and 208 ft. high, with a maximum width at the base of one-quarter of a mile. It is expected that this project will be completed by the latter part of 1930.

Big Creek Power House No. 2A in Operation



Under a static head of 2,419 ft. the 56,000-hp. generating units of the No. 2A plant of the Southern California Edison Company's San Joaquin River Project were placed in operation on Aug. 15. This plant has a total capacity of 112,000 hp. and is the plant on the right in the picture. The station adjacent to it is plant No. 2. The five plants of the Big Creek San Joaquin River series now have a total capacity of 457,700 hp.

Coming Conventions

American Society of Mechanical Engineers, Boston regional meeting, Oct. 1-3; second national fuels meeting at Cleveland, Ohio, Sept. 17-20; Calvin Rice, secretary, 29 West 39th St., New York City.

American Welding Society, fall meeting at Philadelphia, Pa., Oct. 8-12; M. M. Kelly, secretary, 29 West 39th St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 12-16; G. E. Pfisterer, secretary, 53 West Jackson Bld., Chicago.

National Association of Power Engineers, annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago.

National Association Practical Refrigerating Engineers, annual convention at Louisville, Kentucky, Nov. 20-23; E. H. Fox, secretary, 5707 West Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering will be held at the Grand Central Palace, New York City, Dec. 3-8. Address inquiries to the International Exposition Company, Grand Central Palace, New York City.

New England Water Works Association, annual convention at Montreal, Canada, Sept. 18-21, Frank J. Gifford, secretary, 715 Tremont Temple, Boston, Mass.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

World Power Fuel Conference at the Imperial Institute, London, Sept. 24 to Oct. 6.

Obituary

Joseph Andrew Jeffrey, chairman of the board of directors of the Jeffrey Manufacturing Company, died on Aug. 27 at his home in Columbus, Ohio, while in his ninety-second year.

Mr. Jeffrey came to Columbus in 1858 after receiving his early education in the public schools of Clinton County, Ohio, where he was born. He engaged in the banking business in Columbus and helped found the Commercial National Bank.

In 1877 he organized with Francis

Lechner the Lechner Mining Machine Company which ten years latter became the Jeffrey Manufacturing Company. From a small beginning in 1877, Mr. Jeffrey saw his plant grow steadly. It now employs 3,500 men, covers 33 acres of ground and in addition to mining machinery manufactures elevating, conveying and crushing machinery and electric hauling locomotives.

Friends and business associates of Mr. Jeffrey say he was not only a keen business executive, but that he also had a sympathetic understanding of men. He believed in the mutual interest of employer and employee and sought to install a fine spirit of co-operation among his men.

C. KEMBLE BALDWIN, who died in Los Angeles on August 9, had been identified with the belt conveyor from the time when it was first used on a large scale. After graduating from Lehigh University in 1895, he first found employment in the anthracite coal field and in 1898 joined the engineering force of the Robins Conveying Belt Company, which was then introducing the belt conveyor as a means of handling heavy materials. Soon afterward Mr. Baldwin became chief engineer of the company and was largely responsible not only for many improvements in conveying machinery, but for its introduction into many fields in which it is now indispensable.

Through his close study of all the technical requirements and his sound engineering judgment he became a recognized authority in the design of these plants. His courage and his pioneer spirit were attracted by these new problems and he possessed the vision and courage which were required for their solution.

He was a member of many technical societies, including those of the Mining and Mechanical Engineers, the Iron and Steel Institute and the Western Society of Engineers.

PERSONALS

A. S. GOULD has recently been elected secretary of the Oster Manufacturing Company, Cleveland, Ohio. Mr. Gould has been for ten years sales manager of the company, and it will be good news to his many friends in the field tc know that he will continue to fill that position in addition to his new duties as secretary. At the same meeting of stockholders and directors R. B. Tewksbury was re-elected president of the company and Roger Tewksbury, formerly secretary, was elected vice-president and treasurer.

H. W. BROOKS, Lieutenant-Commander U.S.N.R. and consulting power and combustion engineer of New York and St. Louis, sails for London on September 12 for a European visit of several months, to make a study of recent developments in power-plant practice abroad. From September 24 to October 6 he will attend the meetings of the World Power Conference at the Imperial Institute, London, serving as official delegate of the American Society of Mechanical Engineers and the International Railway Fuel Association.

RICHARD H. DANA, formerly vice-president and treasurer of Hodge & Dana, Inc., has become affiliated with the Robins Conveying Belt Company, where he will specialize in the engineering and sale of screens.

BUSINESS NOTES

THE IDEAL COMMUTATOR DRESSER COMPANY, Sycamore, Ill., is now represented in the Rocky Mountain district by the Industrial Supply Co., 121-125 Motor Ave., Salt Lake City, Utah, for the sale of their commutator and motor maintenance equipment.

PAIGE & JONES CHEMICAL COMPANY has purchased from the American Water Softener Company the patent rights and good-will pertaining to the lime-soda water softening business of that company.

THE ELLIOTT COMPANY has appointed E. A. Green, formerly sales engineer in the Philadelphia office, as manager of their Engine Department. This department will develop and handle engines, engine-generator sets, and engine-type generators.

GUILD & GARRISON, INC., announces that Herbert S. Wilson, formerly of the Ingersoll-Rand Company and the A. S. Cameron Steam Pump Works, has been appointed sales manager. Mr. Wilson will be in a position to quote upon the same class of machinery as he handled heretofore.

JACKSON ENGINEERING & EQUIPMENT COMPANY, of Los Angeles, representatives of the Fluor Construction Company, and of Heat Transfer Products, Inc., has moved its main office from 909 East 59th St., Los Angeles, to 1022 Pacific National Bank Building in the same city. The new office will be under the management of Mr. Karl Finsterbusch, who has been in charge of the company's Pacific Coast business for the past year.

THE LUNKENHEIMER COMPANY announces that it has moved its New York branch office to 318-322 Hudson St., corner Vandam St. The new and larger quarters make it possible for them to increase their stock, and thus improve the service rendered their customers.

TRADE CATALOGS

FITTINGS AND VALVES—The Schutte & Koerting Company, Philadelphia, has issued a revised bulletin, No. 7-E, in which they give the prices and properties of their Everdur fittings, valves and jets.

ACROSS-THE-LINE-MOTOR — Bulletin No. 1093 of the Reliance Electric and Engineering Co., Cleveland, Ohio, answers fourteen questions, gives a table of ratings and the characteristic curves of its across-the-line type squirrel-cage induction motors. The bulletin also gives a table of the maximum allowable starting currents recommended by the National Electric Light Association.

STEAM TRAPS—A new four-page bulletin No. 428 of W. H. Nicholson & Company, 12 Oregon St., Wilkes-Barre, Pa., contains information on the Nicholson Super-Trap for pressures up to 600-lb. using superheated steam. Prices, dimensions and capacities are included.

ENGINE-GENERATOR SETS—Bulletin I, a four-page bulletin describing the latest improved design of Elliott engine type alternating-current generators, is just off the press. A product of 20 years' experience in building such machines, the new line of generators incorporates many new and improved features.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.25@$2.60
Kanawha	Columbus	1.25@ 1.60
Smokeless	Cincinnati	2.00@ 2.35
Smokeless	Chicago	2.00@ 2.25
S. E. Kentucky	Chicago	1.35@ 1.60
Steam	Pittsburgh	1.80@ 1.90
Gas Slack	Pittsburgh	1.20@ 1.30
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$3.00
Barley	New York	1.35@ 1.75

FUEL OIL

New York—Sept. 6, f.o.b. Bayonne, N. J.: 28@34 deg., Baumé, industrial use, tank-car lots, 4¾c. per gal.; 36@40 deg., furnace, tank-car lots, 7c. per gal.

St. Louis—Aug. 29, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.35 per bbl. or 42 gal.; 26@28 deg., $1.40 per bbl.; 28@30 deg., $1.45 per bbl.; 30@32 deg., $1.50 per bbl.; 32@36 deg., gas oil, 4.2c. per gal.; 38@40 deg., 4.98c. per gal.

Pittsburgh—Aug. 20, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., 5¾c. per gal.

Philadelphia—Aug. 31, 26@30 deg., $1.94@$2.01 per bbl. or 42 gal.; 13@19 deg., $0.995@$1.065 per bbl.; 22 plus, $1.52@$1.57 per bbl.; 27@30 deg., $2.14@$2.21 per bbl.

Cincinnati—Sept. 3, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Sept. 1, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 57½@ 60c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., 90c. per bbl.

Boston—Aug. 27, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.4c. per gal.; 28@ 32 deg., 5.6c. per gal.

Dallas—Sept. 1, f.o.b. local refinery, 26@30 deg., $1.15 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

California—Northwestern Pacific R.R., St. Paul, Minn., is having plans prepared for the construction of one 2,000 and one 1,335 hp. sub-stations at Sausalito and Baltimore Park, Calif. H. E. Stevens, St. Paul, Minn., is chief engineer.

Calif., Los Angeles — Richfield Oil Co., Bartlett Bldg., awarded contract for a 12 story office and stores building at Sixth and Flower Sts. to P. J. Walker Co., Garland Bldg. Estimated cost $2,500,000.

Calif., San Francisco — Sears-Roebuck Co., represented by H. Rutherford, 2440 Broadway, awarded contract for the construction of a store and loft building at Army, Valencia, Mission Sts. to Scofield Engineering Co., 621 South Hope St., Los Angeles. Estimated cost $1,500,000.

Fla., Avon Park—Florida Public Service Co., plans the construction of an ice and cold storage plant. Estimated cost $150,000.

Kan., Centralia—City awarded contract for the construction of a pump house to R. Knox, Clyde. Estimated cost $25,000.

Ky., Louisville—John W. Norton Memorial Infirmary, 1147 South Third St., awarded contract for the construction of a heating plant and laundry building to L. W. Hancock Co., Louisville Trust Bldg. Estimated cost $41,000.

Ky., Paducah—Anheuser-Busch Inc., 721 Pestalozzi St., St. Louis, Mo., awarded contract for the design and construction of a steam generating plant to consist of three 1,100 hp. 450 lb. boilers with superheaters, two 5,000 kw. turbines, etc. to Ophuls & Hill Inc., 112 West 42nd St., New York, N. Y. Estimated cost approximately $1,000,000. Engineers taking bids on sub-contracts and equipment.

Ky., Paducah—City plans an election Nov. 6 to vote $800,000 bonds for the construction of a municipal light plant. E. Lackey, mayor.

Mich., Pontiac—Bd. of Education, High School Bldg., awarded contract for a 2 story high school including power plant, etc. to O. F. Miller Construction Co., Kalamazoo. Estimated cost $259,495.

Mo., Kansas City—Kansas City Power & Light Co., 14th St. and Grand Ave., plans the construction of a sub-station. Estimated cost $65,000. H. G. Freshman, c/o owner, is engineer.

Mo., St. Louis—A. Leschen & Sons Rope Co., 5909 Kennerly Ave., awarded contract for the construction of a 63 x 90 ft. power plant to Humes-Deal Co., 777 Arcade Bldg. Estimated cost $80,000.

Mo., St. Louis—Plaza Realty Co., W. J. Holbrook, Pres., 1010 Olive St., awarded contract for a 12 story office building at Olive, and Pine Sts. and 12th Blvd. to Boaz-Kiel Construction Co., 1207 Ambassador Bldg. Estimated cost $1,500,000. Steam heating system, etc. will be installed.

Neb., Gordon — City will receive bids until Sept. 17, for the construction of a pumping station, etc. for sewage treatment works. Estimated cost $30,000. Henningson Engineering Co., 326 Union State Bank Bldg., Omaha, is engineer.

N. J., Jersey City—American Can Co., 120 Broadway, New York, N. Y., will build a 90 x 98 ft. boiler house at 315 St. Pauls Ave., here. Estimated cost $50,000. Work will be done by day labor.

N. J., Jersey City—C. Zerman, 157 Harrison St. E., Orange, is having plans prepared for two 5 story apartment buildings including steam heating and refrigeration systems, boilers, elevators, etc. at 252-88 Harrison Ave. here. Estimated cost $1,000,000. Private plans.

N. J., Secaucus—Bd. of Chosen Freeholders, Court House, Jersey City, is having plans prepared for a 4 story hospital including steam heating, ventilation and refrigeration systems, boilers, elevators, etc. on County Ave. Estimated cost $500,000. J. T. Rowland, 30 Journal Sq., Jersey City, is architect.

N. J., Secaucus—Bd. of Chosen Freeholders, T. J. Wasser, Clk., Court House, Jersey City, will receive bids until Sept. 13 for extensions to auxiliary steam line for power house at Hospital for Insane here.

N. Y., Amenia—Dept. of Mental Hygiene, Albany, will receive bids until Oct. 11 for the construction of a power house for Wassau State School here.

N. Y., Sodus—Lamoka Power Co. G. R. Mills, Pres., awarded contract for a power canal, power house, etc. to Dutcher Construction Co., Sodus. Estimated cost $328,380.

N. C., Greensboro—North Carolina Public Service Co., K. K. Garrett, Gen. Mgr., plans the construction of a 13,200 v. high voltage transmission line from Greensboro to Sedgefield suburb to include a sub-station. Estimated cost $35,000.

O., Cleveland—Cleveland Union Terminal Co., C. L. Bradley, Pres., awarded contract for an 18 story medical arts building and garage at Public Square to Lundoff-Bicknell Co., B. F. Keith Bldg. Estimated cost $5,000,000.

Okla., Enid—City is having plans prepared for the construction of a pumping station. Estimated cost $34,000. F. C. Magruder, is engineer.

Tex., Dal Rio—Central Power & Light Co., Frost Bldg., San Antonio, awarded general contract for the construction of second power plant on Devils River near here, to L. E. Meyers Co., 53 West Jackson Blvd., Chicago, Ill. Estimated cost $300,000.

Tex., Higgins—Cities Service Gas Co., 60 Wall St., New York, N. Y., is receiving bids for the construction of a gas compressor station, 5,000 hp. capacity, here. Estimated cost $100,000. Private plans.

Tex., Lefors—Texas Pipe Line Co., subsidiary of Texas Corp., 17 Battery Pl., New York, N. Y., is receiving bids for the construction of a booster plant for 160 mi. oil pipe line now under construction. Estimated cost $100,000. Private plans.

W. Va., Summerville—Gauley Power Co., J. H. Gaines, Pres., has made application to Public Service Commission for permit to construct dam, 125 ft. high on Gauley River above Nanawha Falls, to impound 7,917,000,000 gals. of water and develop 54,000 hp. of electric energy at power station. Estimated cost approximately $8,000,000.

Ont., Toronto—Toronto Terminals Railway Co., Union Station, awarded contract for the construction of a central power and heating plant to Peter Lyall & Sons, Bay St. Estimated cost $200,000.

Equipment Wanted

Boiler—City of St. Peter, Minn., M. E. Stone, Clk, plans to purchase a 250 hp. boiler for proposed central heating plant. Estimated cost $30,000.

Generating Unit—City Commission, City Hall, Saskatoon, Sask., will receive bids until Oct. 10 for a 7,500 or 10,000 kw. steam turbine generating unit complete with condenser and auxiliary equipment.

Motors, Etc.—R. Oughton, Purch. Agt., Los Angeles, Calif., will receive bids until Sept. 26 for four 20 hp. induction motors, etc. for Section No. 3 North Outfall Sewer.

Power Plant Equipment—Bd. of Public Works, Stanberry, Mo., will receive bids until Sept. 25 for equipment including Diesel engines for proposed electric power plant and lighting system. Estimated cost $30,000.

Pumping Equipment—City of Weslaco, Tex., will receive bids until Sept. 14 for pumping equipment for proposed waterworks improvements.

Pumps—City of Sulphur, La., will receive bids until Sept. 18 for two 500 and one 200 g.p.m. pumps, etc. for proposed waterworks and distribution systems. Estimated cost $60,000.

Refrigeration Equipment—Dept. of Mental Hygiene, Albany, N. Y., will receive bids until Oct. 11, for refrigeration equipment for cold storage plant at Wassaic State School, Amenia, N. Y.

Refrigeration Equipment—Dept. of Mental Hygiene, Albany, N. Y., will receive bids until Oct. 10 for refrigeration equipment, etc. for New York State Psychiatric Institute and Hospital, New York, N. Y.

Industrial Projects

Calif., Richvale — PULP and PAPER MILL — Pacific Coast Paper Co., awarded contract for the construction of a group of buildings for pulp and paper mill to T. B. Hunt, 1510 30th St., Sacramento. Estimated cost $1,000,000.

Calif., Vernon—OIL REFINERY—Swift & Co. awarded contract for a 2 and 4 story, 115 x 215 ft. oil refinery to Richards-Neustadt Construction Co., National City Bank Bldg., Los Angeles. Estimated cost $135,000.

Ia., Sioux City — PACKING PLANT ADDITION — Sioux City Stock Yards Co., G. F. Silknittel, Pres., awarded contract for a 250 x 330 ft. addition to packing plant to W. A. Klinger, Inc., Warnock Bldg. Estimated cost $210,000.

Kan., Wichita—PACKING PLANT—F. Dold & Sons Packing Co., 21st and Lawrence Sts., awarded contract for a 1 story, 100 x 180 ft. packing plant to Siedhoff Construction Co., Broadview Hotel Bldg. Estimated cost $125,000.

Mich., Detroit — PRODUCE STORAGE WAREHOUSE — The Great Atlantic & Pacific Tea Co., 5470 Hecla St., awarded contract for a 3 story, 120 x 295 ft. produce storage warehouse to The Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $300,000.

Mo., St. Louis—GENERATOR MANUFACTURING PLANT ADDITION—Chandeysson Electric Co., 4092 Bingham Ave., awarded contract for a 1 story addition to plant for the manufacture of plating generators and similar electrical equipment to Widmer Engineering Co., 201 Roosevelt Bldg. Estimated cost $65,000.

N. Y., Buffalo — BISCUIT FACTORY—Ontario Biscuit Co., 273 Oak St., awarded contract for a 4 story, 80 x 96 ft. factory at 20 Watson St. to Hydro Construction Co., Mutual Bldg. Estimated cost $90,000.

N. Y., Queens Village—BAKERY—Duggan Bros., 288 South 5th St., Brooklyn, will soon award contract for a 1 and 2 story, 200 x 260 ft. bakery including refrigeration system, pump house, etc. at 99th Ave. and 222nd St. here. Estimated cost $300,000. H. Holder, 242 Franklin Ave., Brooklyn, is architect.

N. C., High Point—BOX FACTORY—Carolina Container Co., J. Pringle, Pres., recently incorporated for $200,000, plans the construction of a factory for the manufacture of all kinds of corrugated boxes and shipping containers. Estimated cost $200,000.

N. C., Waynesboro—RAYON MANUFACTURING PLANT — E. I. Du Pont de Nemours & Co., Wilmington, Del., plans to expend $46,000,000 for construction of and equipment for a rayon manufacturing plant, comprising eight units, here.

O., Chillicothe—TILE FACTORY—Buckeye Tile Co., will soon receive bids for a 1 story, 104 x 200 ft. factory. Estimated cost $40,000.

Tenn., Dyersburg — COTTON MILL — Dyersburg Cotton Products Co. awarded contract for a 3 story, 130 x 700 ft. factory including boiler plant, etc. to Gauger-Korsmo Construction Co., Co., Fidelity Bank Bldg. Estimated cost $400,000.

Tex., Wharton — COTTONSEED OIL MILL — Farmers Gin Co., Georgetown, is having plans prepared for the construction of a cottonseed oil mill, electrically equipped, near here. Estimated cost $70,000.

Ont., Hamilton — HOSIERY MILL — National Hosiery Mills, Ltd., J. M. Moore & Co., will soon award contract for a 2 story, 100 x 120 ft. mill on King St. Estimated cost $75,000. John M. Moore & Co., 489 Richmond St., London, are architects.

Ont., Walkerville — FACTORY—General Motors Co. of Canada, Oshawa, awarded contract for steel sash for a 1 story, 150 x 160 ft. factory here.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

PRICES throughout the entire list are firmer with the exception of linseed oil, which declined 0.2c. per lb. in the New York market during the month. Boiler rivets are considerably higher at Pittsburgh mills. Highest grade babbitt metal rose ¼c. per lb. at New York warehouses. Quotations on armored cable show a rise of $1 per 1,000 ft., compared with August levels. Lower discounts are announced on renewable fuses.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 60c. per ft.
Common, 2½-in., cotton, rubber-lined	80c. per ft. list, less	50%

Air—Best grade

¾-in., per ft.	3-ply	$0.30	4 ply	$0.36

Steam—Discounts from List

First grade	40%	Second grade	45%	Third grade	50–10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50%	Second grade	60%

LEATHER BELTING—List price, 24c., per lin.ft. per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium	30–10%
Heavy	25–5%

RAWHIDE LACING—For cut, best grade, 30–10%; 2nd grade, 50–10%. For laces in sides, best, 55c. per sq.ft.; 2nd, 50c. Semi-tanned, cut, 30–10%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ¼ in	$0.90
Asbestos for high-pressure steam, ½ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia, high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.25@$2.35 per bbl. without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots of 250 to 2,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00
Colored	9.00@13.00	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.17
New York	.15½
Cleveland (*per thousand*)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.105	$0.105	$0.103

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, small, including ⅞-in. dia., list (Apr. 1, 1927) less 50-10% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., per 100 lb.:
New York, $5.00* Chicago, $3.60 Pittsburgh mill, $2.90

Cone-head boiler rivets, ½-in., per 100 lb.:
New York, $5.00* Chicago, $3.90 Pittsburgh mill, $3.20

*Price is for full packages; broken package lots, $6.50 net, delivered.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	per net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	per net ton	26@29
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	per net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	68.00
Commercial genuine, intermediate grade	53.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	12.25

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.60
Flat or square	3.90	4.15	4.10

BOILER FITTINGS—F. o. b. New York or Jersey City, discounts from list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	62	50½	1 to 1¼	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouses on tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17.07
1¼	.....	.....	19.20
1½	.....	$38.00	17.92
1¾	.....	28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3¼	30.25	49.50	30.67
3½	31.50	52.75	33.33
4	38.03	67.00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.
These prices are net, per 100 ft., based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.
In addition to the above, standard cutting charges are as follows:
2 in. and smaller.. 5c. per cut. 3 in..... 9c. per cut.
2¼ and 2½ in..... 6c. per cut. 3¼ to 4 in.... 10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$31.00 (net)	$45.00 (net)	$180.00	$220.00
No. 12 solid	136.00	180.00	225.00	275.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	305.00	375.00	420.00	500.00
No. 6 stranded	440.00	530.00	615.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	30%
Coils to 1,000 ft.	60%	35%
1,000 to 5,000 ft.	65%	38%
5,000 ft. and over	67%	40%

CONDUIT—Price per 1,000 ft.: **ELBOWS AND COUPLINGS**, per 100 pieces, extra f.o.b. New York warehouse. Discount of 5 per cent. for payment in 10 days. Delivery charges, approximately 4 per cent. additional.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50.13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508.50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$16.50
No. 16 cotton reinforced heavy		20.00
No. 18 cotton reinforced light		13.00
No. 16 cotton reinforced light		17.60
No. 18 cotton Canvasite cord		14.60
No. 16 cotton Canvasite cord		16.90
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$72.00	*80.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	110.00	*122.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100-amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 64%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp	$0.03 ea.	$0.05	100	100
35 to 60-amp	.05 ea.	.06	100	100
65 to 100-amp	.10 ea.	.10	50	50
110 to 200-amp	.15 ea.	.15	25	50
225 to 400-amp	.30 ea.	.30	25	25
450 to 600-amp	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	22%
Ten unbroken cartons	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons	26%
Ten unbroken cartons	42%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	42%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.50
0-30 ampere, less than standard package	2.80

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.22	....	....	....
60	A 21	.22	....	....	....
100	A 23	.35	....	....	....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$5.75	$8.00	$9.75	$16.00
12	8.80	10.20	12.10	22.00
10	11.90	14.00	16.00	28.90
8	17.50	19.20	20.15	39.50
6	.....	.....	30.00	.....
4	.....	.....	42.00	.....
2	.....	.....	60.00	.....
1	.....	.....	82.00	.....
0	.....	.....	101.00	.....
00	.....	.....	119.00	.....
000	.....	.....	142.00	.....
0000	.....	.....	172.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., less than 100 lb., 31c. per lb.	100 lb. lots	29c per lb.
Rubber tape, ¾ in., less than 100 lb., 33c. per lb.	100 lb. lots	31c per lb.
Wire solder, less than 100 lb., 33c. per lb.	100 lb. lots	31c. per lb.
Soldering paste, 2 oz. cans		$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25.00 to $50.00 list value	30–5%
$50.00 list value or over	35%